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Constructing a Reference Event List for ARCESS

Florence Rivière-Barbier

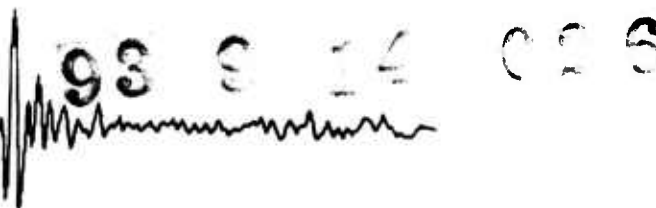
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Special Technical Report C93-03

August 25, 1993

Constructing a Reference Event List for ARCESS

Florence Rivière-Barbier

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A cluster analysis method has been applied to a data set consisting of thousands of events recorded at ARCESS. Northern Scandinavia has been divided into smaller areas in which seismic events were organized into groups of similar events. The locations of these groups have been compared with known mine locations in Northern Scandinavia. Many of these groups have been associated with these mines. For comparison purposes, reference events were defined for each group.

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1. INTRODUCTION

In order to automatically identify the largest number of these events and to simplify the analyst task in locating and identifying events, a method was developed to identify and locate events using the principle of "reference events". The event classification method, described by Rivière-Barbier and Grant (1992), was originally tested on a small data set of events located in Karelia (Russia). In this study, the data set has been extended to all the events included in the IMS database. Since most of events available in the database were located in Scandinavia, this area has been studied first.

Scandinavia was divided into 64 smaller areas in order to facilitate the classification of the events (Figure 1). The largest areas cover 2° in latitude and 6° in longitude. The dimensions of the areas were chosen to vary with respect to the density of events. For instance, 146 events were located in area 25 by the IMS while areas 15, 16, 17 and 18, representing the same total area as area 25, included 2232 events. Within each area, the data were selected in order to build a representative data set with sufficient events for analysis.

This report presents the results of the areas located around the ARCESS array (Figure 1, from area 1 to area 30). Recordings on the vertical channel (sz) of the central element (ARA0) were used in the waveform comparison process. Processing parameters, general information and results have been compiled for each area. Processing parameters are listed in Appendix 2 and mine locations from different sources are listed in Appendix 3.

2. AREA DESCRIPTION

Each area in this study is described in Appendix 1. The parameters used to characterize the areas are given below.

2.1. Latitude

Upper and lower latitude limits of the studied area are given in this field. For the part of Scandinavia described in this report, the lowest latitude is 64 degrees and the highest latitude is 72 degrees. Area sizes in latitude can vary from 0.5 degrees to 2 degrees. All latitudes given in this report are North of the Equator.

2.2. Longitude

Upper and lower longitude limits of the studied area are given in this field. For the part of Scandinavia described in this report, the smallest longitude is 5 degrees and the largest longitude is 38 degrees. Area sizes in longitude can vary from 1 degree to 6 degrees. Longitudes given in this report are East of the Greenwich meridian.

2.3. Number of events in IMS2

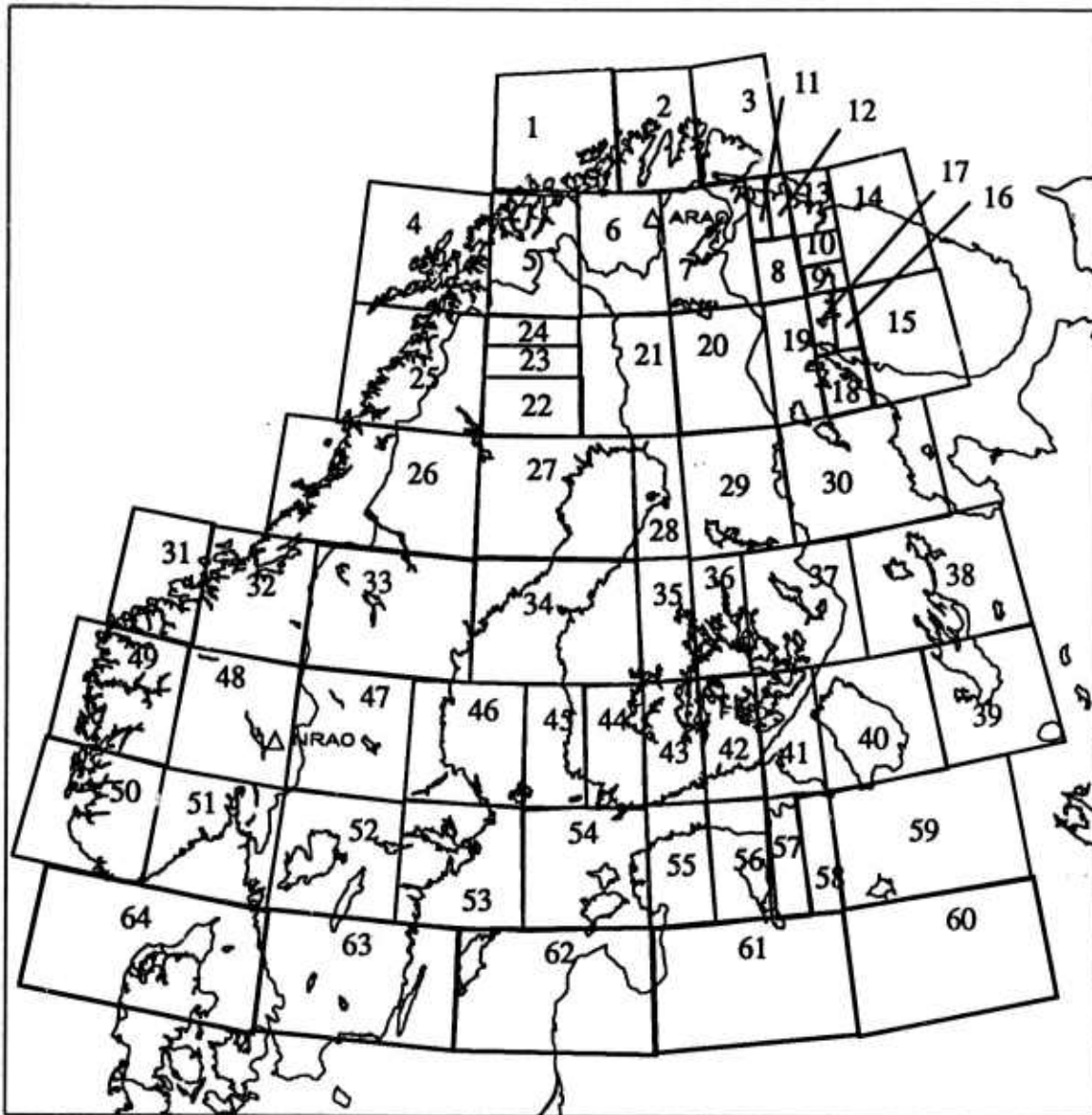


Figure 1: Map of Scandinavia showing the 64 areas that are being used to define a list of reference events for each array NORESS, ARCESS and FINESA. The arrays are represented by their central element: NRA0, ARA0, FIA0.

This is the number of events located within a particular area by the IMS and stored in the IMS2 database account at the time of the selection, January 31, 1993.

At that time, the database contained events that occurred between November 1990 and January 27, 1993.

2.4. Local magnitude range

The local magnitude range is used to select the events from a particular area. The range is used to obtain a representative data set of the area. The events were selected based on decreasing magnitude in order to get the largest events. When no magnitude range is given, all events located in the area were used in the processing. This happened when too few large events were available for a given area.

2.5. Number of events within the magnitude range

This number is either equal to or lower than the number of events in the IMS database. Not all events located by the IMS and whose locations are stored in the database have waveforms. Technical problems at the array, software and hardware failures, and misidentification by the expert system can lead to lost of waveforms.

2.6. Number of processed events

The number of processed events is, in most cases, smaller than the *number of events within the magnitude range*. A specific length of signal is required for the computation, and the waveform segment available on disk may not be long enough. Also, an event recording can be made of two waveform segments, a case that is not handled by the processing program.

2.7. Frequency range used to process the data

For each area, a frequency range is defined to filter the data. The high frequency corner is always set to 16.0 Hz. The low frequency corner varies from 0.5 to 5 Hz. Some data would require a band reject filter which is not available in the current version of the software.

2.8. Processed signal length

The signal length needed for processing should include all phases and therefore, is distance dependent. The signal length is defined to contain the beginning of the first phase and the end of the last phase associated with the event. The total length includes the signal plus 1/8 of the signal length at each end since a 10% cosine taper is applied to the data.

2.9. Number of reference events

This gives the number of events that need to be used to identify most of the events located within a given area. The table listing these reference events gives the following information:

- the event number: related to the processing;
- the IMS orid: IMS event number in the database;
- the IMS arid: IMS number for the first phase associated with the event at the array;
- the IMS wfid: IMS waveform number, in this study only waveforms recorded at the central element of the array (ARA0) on the vertical channel (sz) were used;
- the threshold: lowest cross-correlation value between a given reference event

characterizing a group and any event in this particular group. Below this value, events do not belong to the group represented by the reference event;

- the group: corresponds to the event classification using the cluster analysis method.

2.10. Reported mine locations

Scandinavia has a very large and important mining industry. The vast majority of the events recorded in the area are related to the mining activity either directly as mine blasts or indirectly like as induced events (tremors). In Appendix 3, lists of the different mine locations are given. These lists have four main sources: SPOT photos, the bulletin published by the University of Helsinki, the Norwegian bulletin, and Joint Operations Graphic (JOG) maps from the American Defense Mapping Agency. The mine locations found on SPOT photos are the most reliable locations but the SPOT photos available cover only a small part of the studied area. The locations provided in the Helsinki bulletin have recently been updated based on SPOT locations and on information that the Finnish researchers have obtained directly from the mines. Based on these new locations, the Helsinki mine labelling changed after May 1991. This list is probably the most complete list for Scandinavia despite the fact that some large mines located outside of Finnish territory are missing. The Norwegian bulletin gives a list of accurate mine locations located mostly in Norway. The JOG maps give accurate mine locations but they are not recent enough: some new mines may be missing and old mines may not be active any more. For each area, a table gives:

- the label: symbol used on the IMS maps,
- the location: latitude and longitude,
- the source of information.

2.11. Number of events found in the Helsinki bulletin

The bulletin published by the University of Helsinki provided extensive lists of events occurring in Scandinavia. Most of the mining events reported in this bulletin have a "manual location" which means that the Finnish analysis visually assigned these events to a particular mine.

A software was used to match the events reported in the Helsinki bulletin with the studied events applying the parameters used during the GSETT II experiment:

- the distance between associated events should not be more than 3°,
- the difference in origin time should not be more than 60 seconds.

However, events with distance differences of more than 2 degrees and/or time differences of more than 30 seconds were not considered, and therefore, the number of events found in the Helsinki bulletin that were associated with events in the IMS database was larger than the number of events listed in the tables of this report.

For each area, a table listing the studied events that were found in the Helsinki bulletin based on the criteria described above gives:

- the event number: this number is related to the processing,
- the event orid: number identifying the event in the IMS database,
- the origin time: from the IMS origin table,
- the local magnitude: from the IMS origin table,
- the Helsinki location: either a latitude and longitude if the event was located automatically or a mine label if the event was located manually,
- the Helsinki identification: if the event was located manually, the label 'EXP' (for explosion) is used, if the event was identified as being an earthquake, the label 'EART' is used, if the event was identified as being probably an earthquake, the label 'P.E.' is used and if the event was identified as being probably a quarry blast, the label 'P.QB' is used. When the event was not identified in the Helsinki bulletin, no label is shown,
- the group: corresponds to the event classification using the cluster analysis method.

2.12. Events with the most reliable classification

For each area, events were sorted into groups based on their waveform similarities. A table gives the list of the events included in each group. Events with a too low signal-to-noise ratio and events that were mixed with other events on the same waveform (except when these events were very large and when they all belonged to the same group) were not included in this list. The table includes the following information:

- the event number: this number is related to the processing,
- the event orid: number identifying the event in the IMS database,
- the origin time: from the IMS origin table,
- the location: from the IMS origin table,
- the local magnitude: from the IMS origin table,
- the group: corresponds to the event classification using the cluster analysis method.

2.13. Remarks

For each area, comments are made about the events and their classification. Comparisons are made between mine locations and event locations. Any particular features seen on the data are reported.

2.14. Mine and event locations

A map showing the IMS event locations and the mine locations from SPOT photos, from the Helsinki bulletin and from the Norwegian bulletin are plotted for each area. This map allows the comparison between the different sets of mine locations mentioned

above as well as the comparison between the event locations and the mine locations.

3. CONCLUSION

One-thousand-nine-hundred-thirty-three events were processed during this study. One hundred-fifty-eight reference events have been defined to represent the event types recorded at ARCESS for distances between 0 and 7.69 degrees. Among the studied event, one thousand-three-hundred-thirty-five events were reliably associated with a reference event and five-hundred-sixty-one events were found in the Helsinki bulletin.

Some reference events may be redundant because some event clusters overlap several areas. They will be eliminated from the final list of reference events that will be used in the Event Identification module. Comparisons with other sources of information have shown that more than one reference event can be necessary to characterize the signals coming from a particular mine (e.g. Kiruna and Varanger mines). For areas where the mines are separated by only a few kilometers and where information is lacking, a reference event can represent the signals coming from more than one mine.

For several areas, no reference events were defined at all. This occurred either because the events had too low signal-to-noise ratios and/or because all of the events were dissimilar. Areas where only a few tens of events were located by the IMS typically had these problems. The distance seems to have less influence than the quality of the data; for instance, no reference events are given for areas 26 and 27 while several reference events are listed for areas 28, 29 and 30 which are more distant to the array than areas 26 and 27. It is more difficult to define reference events for areas where scattered earthquakes are located (area 27) in opposition to areas with mining activity or areas with swarms of earthquakes (area 25).

The comparison between mine locations from diverse sources and the IMS locations show that for many areas, a location bias in distance and azimuth could be observed. Between 0 and 220 km from the array, events are usually located too far away with respect to their "true" locations (e.g. events from the Varanger mine). Over 220 km, events are located too close to the array (e.g. events from the Kiruna mine). The distance has been studied by Ryaboy (1992) and the azimuthal bias has been studied by Suteau-Henson (1992).

For most of the studied areas, IMS event locations form clusters around a particular location; this feature characterized mining activity. For some areas, the cluster can directly be associated with a mine found on a SPOT photo or reported in one of the bulletins (e.g. area 19). For other areas, the density of mines prevents any association between a cluster of events and a particular mine (e.g. area 10). A third category of areas consists of areas where an event cluster can be seen but no mine locations have been reported by our

sources (e.g. area 5).

Many earthquakes have been identified by the Finnish analysts in Scandinavia during the time period covered by the data set. Most of them were unique, in the sense that no aftershocks were detected except for a swarm of earthquakes that occurred in Steigen (Norway). This swarm, located in area 25, has been identified using information from the "ground-truth database" (Grant, 1992).

This method using the list of reference events determined here has already been partially implemented in the IMS. The next steps will be to test the list of reference events defined for the ARCESS array on all events located in Scandinavia by the IMS in order to evaluate the capabilities of the method for different magnitude ranges; to automate the method of determining the reference events, and to build similar lists for the NORESS, FINESA and GERESS arrays.

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APPENDIX 1

AREA 1

Latitude: 70 - 72°N

Longitude: 18 - 24°E

Local magnitude range: > 1.0

Reported mine locations: None

Number of events in IMS2: 186

Number of events within the magnitude range: 56

Number of processed events: 46

Number of events found in the Helsinki bulletin: None

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 4s. before P, 38s. after P

Number of reference events: 2

Table 1: Reference events for area 1

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
46	339219	1439257	2693160	0.83	A
27	30690	855259	1008248	0.81	B

Events with the most reliable classification:

Table 2: Sorted events for area 1

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
1	10105	11/30/90	13:26:00.1	70.2549	21.7369	1.03	A
20	26727	6/14/91	12:26:28.2	70.3650	21.6609	1.12	A
21	26728	6/14/91	12:26:39.4	70.2800	21.7079	1.41	A
32	33283	8/6/91	19:25:51.5	70.3146	21.5423	1.17	A
37	300508	10/18/91	13:26:18.0	70.2554	21.6794	1.16	A
38	302432	11/29/91	13:28:52.9	70.2595	21.3960	1.11	A
39	321697	3/6/92	13:26:04.0	70.4300	21.8751	1.19	A
41	324445	4/10/92	12:25:22.8	70.1908	22.7734	1.16	A
42	327352	5/8/92	12:27:00.0	70.2285	21.9835	1.23	A
44	337260	8/28/92	12:23:57.7	70.1760	22.5852	1.16	A
46	339219	9/18/92	12:24:53.2	70.1411	22.7680	1.05	A
2	17222	4/12/91	18:12:35.2	70.0986	20.3555	1.51	B

Table 2: Sorted events for area 1

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
3	19456	4/20/91	14:11:06.8	70.0328	20.4866	1.26	B
4	19039	4/24/91	11:07:14.2	70.0320	20.4357	1.23	B
5	19085	4/24/91	19:04:01.1	70.0855	20.6009	1.39	B
6	20016	4/25/91	18:59:32.3	70.0654	20.3075	1.28	B
7	20139	4/30/91	21:56:07.8	70.0797	20.6189	1.44	B
8	20438	5/3/91	10:32:46.8	70.1323	20.6331	1.02	F
9	21232	5/8/91	16:08:49.9	70.0524	20.7105	1.13	B
10	22195	5/13/91	17:47:59.4	70.2426	20.5928	1.02	B
11	23780	5/27/91	06:45:02.9	70.0717	20.3969	1.14	B
12	24030	5/28/91	18:32:36.9	70.0724	20.4711	1.18	B
13	24378	5/29/91	16:06:20.0	70.0424	20.6248	1.10	B
14	24445	5/31/91	10:04:32.3	70.0771	20.4804	1.11	B
15	24856	6/3/91	18:59:45.0	70.0799	20.5733	1.15	B
16	25064	6/4/91	18:22:40.8	70.0298	20.5298	1.36	B
17	25425	6/7/91	06:39:09.8	70.0835	20.5993	1.07	B
18	25572	6/8/91	10:28:33.1	70.1005	20.4137	1.10	B
19	25809	6/10/91	20:32:33.7	70.0790	20.3969	1.37	B
22	26497	6/16/91	20:22:07.7	70.0418	20.5441	1.19	B
23	28202	6/29/91	13:54:03.4	70.0500	20.5107	1.09	B
24	28446	7/4/91	18:44:52.7	70.0488	20.4533	1.09	B
25	28667	7/6/91	13:48:15.7	70.0009	20.3531	1.14	B
26	30007	7/8/91	20:38:35.9	70.0094	20.2896	1.54	B
27	30690	7/21/91	16:06:22.6	70.1757	20.5006	1.32	B
28	31937	7/25/91	11:43:02.7	70.1750	20.4997	1.18	B
29	31661	7/26/91	13:54:49.9	70.1104	20.5618	1.11	B
31	33253	8/6/91	16:11:29.5	70.0707	20.5350	1.28	B
33	34148	8/7/91	13:22:27.1	70.0491	20.3212	1.14	B
34	33851	8/9/91	12:57:21.9	70.0873	20.5597	1.30	B

Table 2: Sorted events for area 1

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
35	34340	8/13/91	18:35:10.6	70.0514	20.3622	1.39	B
36	34884	8/18/91	18:05:53.9	70.0990	20.4381	1.19	B

Remarks:

- Despite their magnitude being above 1.0, none of these events was reported in the Helsinki bulletin.
- These events clearly originate from two individual sources. As seen on Figure 2, events from group A form a tighter cluster than events from group B.
- Except for one event, events from group A show consistent origin times: around 12:25 (summer time) and 13:25 (winter time). Origin times for events from group B are widely spread in time.

Mine and event locations:

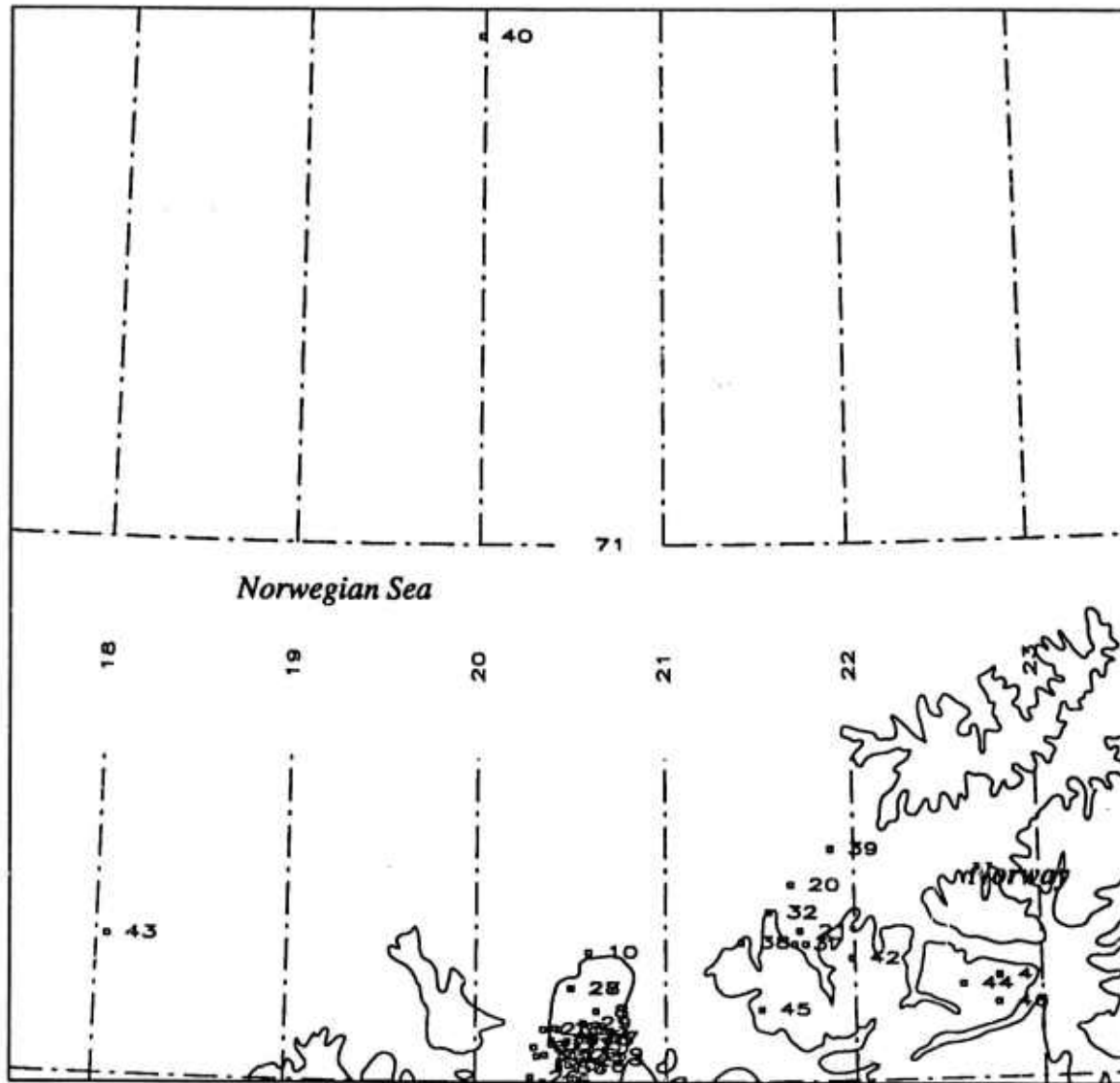


Figure 2: IMS event locations for area 1.

AREA 2

Latitude: 70 - 72°N

Longitude: 24 - 28°E

Local magnitude range: > 0.5

Reported mine locations: None

Number of events in IMS2: 137

Number of events within the magnitude range: 58

Number of processed events: 52

Number of events found in the Helsinki bulletin: None

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 4s. before P, 34s. after P

Number of reference events: 3

Table 3: Reference events for area 2

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
37	324318	1231825	1931736	0.82	A
20	301540	1006168	1411450	0.86	B
7	32522	870589	1066283	0.95	C

Events with the most reliable classification:

Table 4: Sorted events for area 2

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
1	8840	1/24/91	13:29:00.9	71.1563	26.1382	0.57	A
2	13516	3/7/91	15:01:15.0	71.1767	26.1860	0.72	A
3	22406	5/15/91	13:28:55.4	71.0849	26.3486	0.67	A
4	24113	5/29/91	13:29:08.9	71.0711	26.4691	0.71	A
10	35799	8/20/91	19:09:33.6	70.8735	26.2909	0.72	A
28	313526	1/30/92	12:54:25.4	70.9830	26.7224	0.75	A
29	316674	2/21/92	11:25:41.4	70.8822	26.2673	0.57	A
36	323880	4/6/92	13:16:23.6	70.9557	25.8255	0.74	A
37	324318	4/9/92	12:27:12.5	71.0545	26.1534	0.71	A
38	325586	4/23/92	13:33:59.7	70.9935	26.1239	0.93	A
39	327240	5/7/92	12:33:02.3	71.0709	25.9262	0.75	A

Table 4: Sorted events for area 2

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
40	328318	5/19/92	13:41:08.8	71.0579	25.9543	0.63	A
41	329027	5/26/92	13:13:52.5	71.0094	25.9174	0.79	A
42	332989	6/24/92	13:20:38.7	71.0641	26.0970	0.54	A
43	332190	7/2/92	09:49:22.3	70.8710	26.2418	0.55	A
47	340448	9/30/92	12:57:47.6	71.0719	26.0906	0.88	A
48	341260	10/13/92	13:25:07.4	70.9783	25.9840	0.63	A
49	342290	10/27/92	13:34:56.5	71.0249	26.6466	0.79	A
50	343280	11/10/92	11:00:06.8	70.9589	26.3290	1.15	A
11	38581	9/11/91	12:24:49.2	71.0373	24.4451	0.65	B
12	39980	9/19/91	08:40:27.5	71.0079	24.5354	0.72	B
14	300557	10/24/91	07:34:24.4	71.1015	24.4681	0.89	B
15	300558	10/24/91	07:53:29.8	71.0921	24.4458	0.88	B
16	300689	10/24/91	08:03:06.4	71.0928	24.4556	0.90	B
17	300690	10/24/91	08:22:56.2	71.1024	24.4060	0.89	B
18	300560	10/24/91	08:33:30.8	71.1049	24.4374	0.90	B
19	301518	11/14/91	09:34:33.2	71.1178	24.4435	1.03	B
20	301540	11/15/91	11:21:12.4	71.1767	24.4491	1.00	B
21	301541	11/15/91	11:34:01.3	71.1574	24.4865	1.01	B
22	301543	11/15/91	11:42:03.7	71.1894	24.6722	0.99	B
23	301673	11/15/91	11:50:40.6	71.2002	24.2036	0.96	B
24	301544	11/15/91	12:05:02.1	71.1320	24.3189	0.91	B
25	301545	11/15/91	12:12:30.9	71.1037	24.4459	0.88	B
26	301546	11/15/91	12:20:47.3	71.1862	24.3457	0.89	B
27	301547	11/15/91	12:30:06.2	71.1822	24.1852	0.92	B
31	319667	3/6/92	14:07:36.7	71.0239	24.4218	0.60	B
32	319782	3/4/92	13:40:53.7	71.0739	24.4628	0.53	B
34	320118	3/10/92	11:56:48.6	71.0366	24.3070	0.54	B
7	32522	7/31/91	20:23:58.9	71.0050	24.0496	0.54	C
8	32527	7/31/91	21:30:44.5	71.0008	24.0137	0.53	C
9	32540	7/31/91	22:56:01.4	70.9880	24.0925	0.52	C

Remarks:

- Events from group B are all located off-shore. They show specific origin time: most of them occurred either on October 24, 1991 or on November 15, 1991.
- All events from group C occurred on the same day (July 31, 1991).
- Events from group A have scattered locations and seem to occur more randomly over the year.

Mine and event locations:

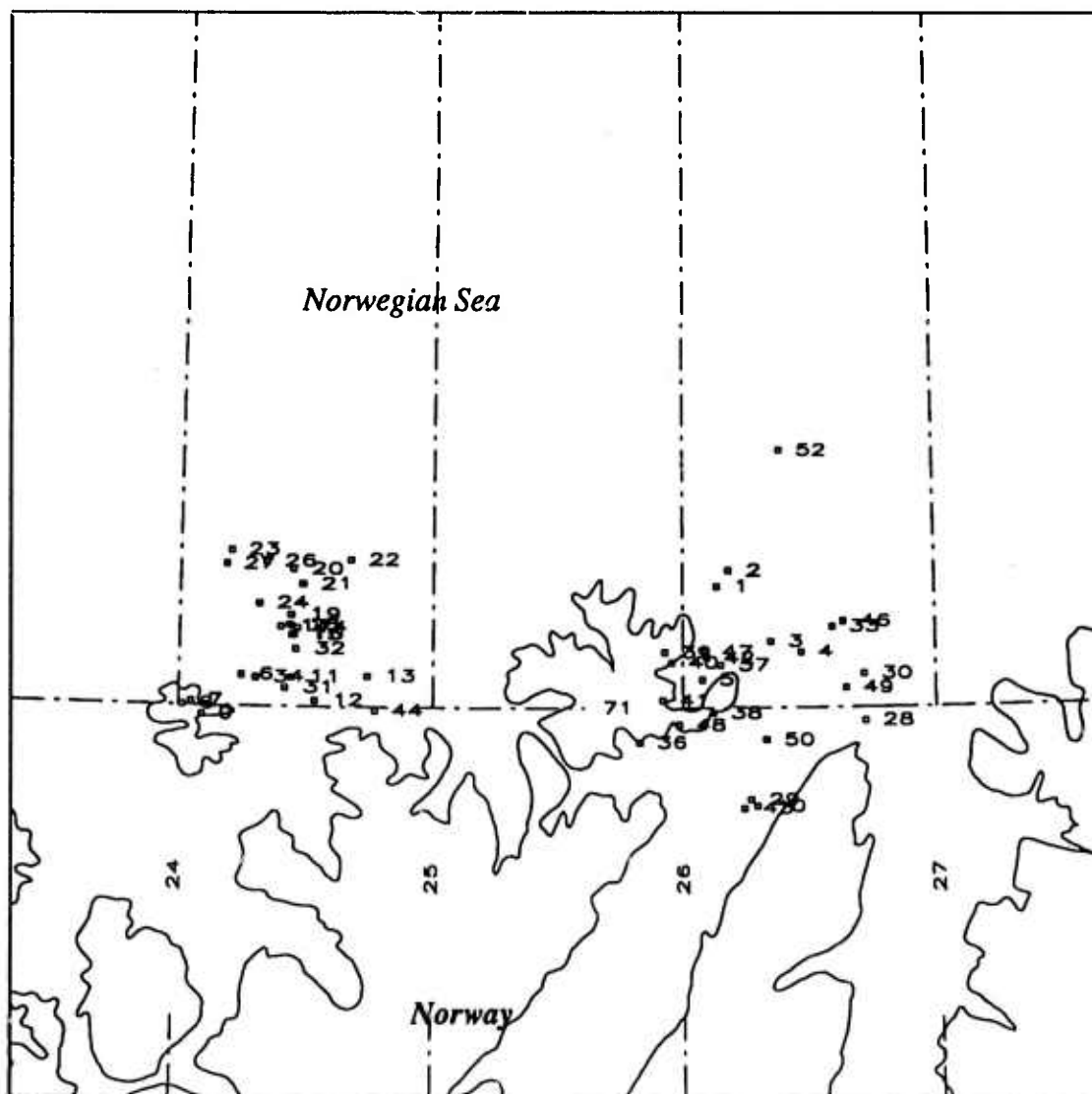


Figure 3: IMS event locations for area 2.

AREA 3

Latitude: 70 - 72°N

Longitude: 28 - 32°E

Local magnitude range: > 1.0

Number of events in IMS2: 154

Number of events within the magnitude range: 69

Number of processed events: 67

Frequency range used to process the data: 1 - 16 Hz

Processed signal length: 4s. before P, 34s. after P

Number of reference events: 5

Table 5: Reference events for area3

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
67	345676	1536332	2886149	0.82	A
2	14423	711394	500327	0.81	B
14	29288	841401	974876	0.81	C
46	335047	1379651	2434480	0.86	D
50	335771	1390884	2465770	0.87	E
1	8256	652135	1361299	-	F

Reported mine locations:

Table 6: Mine locations for area3

Label	Latitude °N	Longitude °E	Origin
(Varanger)	70.48	28.50	S. Mykkeltveit

Number of events found in the Helsinki bulletin: 1

Table 7: Events found in the Helsinki bulletin for area 3

Event #	IMS orid	IMs origin time		IMS ml	HEL location		HEL label	Group
1	8256	12/16/90	00:58:27.5	2.26	71.14	27.49	P.E.	-

Events with the most reliable classification:

Table 8: Sorted events for area 3

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
13	29987	7/8/91	16:52:23.6	70.5091	29.3064	1.11	A
25	41660	9/25/91	15:04:22.2	70.4087	28.8118	1.23	A
32	323498	4/2/92	17:18:37.6	70.3956	28.8336	1.01	A
59	340941	10/7/92	13:31:16.9	70.3787	29.1637	1.14	A
67	345676	12/16/92	17:20:30.0	70.3657	28.9156	1.07	A
2	14423	3/20/91	13:35:38.3	70.3116	29.1352	1.03	B
26	300682	10/30/91	13:25:08.5	70.3969	29.0555	1.10	B
28	302258	12/4/91	08:41:23.0	70.3164	29.3765	1.08	B
29	302581	12/11/91	14:09:12.6	70.3471	29.1354	1.18	B
36	328669	5/22/92	07:34:35.3	70.3599	29.2422	1.04	B
62	342233	10/26/92	13:54:04.1	70.3779	28.7142	1.08	B
4	22312	5/8/91	15:18:00.1	70.4449	29.4308	1.31	C
12	28464	7/4/91	21:10:35.8	70.3046	28.8988	1.03	C
14	29288	7/11/91	21:23:42.8	70.4305	28.9595	1.22	C
19	34432	8/14/91	12:28:16.5	70.3607	28.9402	1.21	C
27	302296	11/26/91	07:27:54.4	70.4256	29.4292	1.38	C
30	320329	2/26/92	17:55:31.5	70.3270	29.6533	1.03	C
31	321425	3/19/92	17:02:03.4	70.4210	29.0862	1.06	C
7	25686	6/5/91	13:34:39.6	70.3588	29.3286	1.24	D
9	26032	6/11/91	13:12:43.4	70.2785	28.5411	1.53	D
10	27008	6/24/91	12:47:01.1	70.3854	28.8890	1.05	D
11	28100	6/26/91	10:31:19.4	70.4157	28.9726	1.66	D
15	31194	7/20/91	16:53:30.8	70.3707	29.3376	1.89	D
18	34143	8/7/91	12:43:58.5	70.3466	28.6307	1.65	D
24	38258	9/5/91	17:07:51.2	70.3763	29.5515	1.80	D
40	331025	6/18/92	16:52:42.5	70.2621	28.6545	1.59	D
41	331475	6/24/92	03:20:56.9	70.2450	28.6744	1.54	D
42	332973	7/11/92	13:47:01.7	70.3860	28.7859	1.32	D

Table 8: Sorted events for area 3

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
43	333133	7/12/92	14:57:45.8	70.3653	28.6790	1.18	D
44	334953	7/15/92	21:18:05.0	70.4676	29.2107	1.46	D
45	334551	7/28/92	16:34:08.8	70.3631	29.2964	1.15	D
46	335047	8/4/92	07:59:57.6	70.2132	28.7836	1.37	D
48	335341	8/7/92	17:18:50.4	70.4333	29.0271	1.11	D
49	335596	8/11/92	16:55:47.5	70.3241	28.9398	1.33	D
51	337183	8/27/92	16:40:04.8	70.2700	28.5995	1.36	D
53	337803	9/3/92	15:10:09.1	70.3482	29.2638	1.38	D
55	340107	9/25/92	07:30:20.3	70.3082	28.8569	1.44	D
56	340337	9/28/92	17:24:54.3	70.3280	28.9632	1.46	D
3	21592	4/30/91	15:11:56.7	70.4199	29.2814	1.24	E
5	24338	5/29/91	14:59:04.2	70.3602	28.9529	1.26	E
6	25047	6/4/91	13:41:16.2	70.4195	29.0910	1.18	E
8	25987	6/8/91	11:30:44.0	70.3345	29.5835	1.55	E
17	33006	7/30/91	23:21:47.4	70.4796	29.2900	1.53	E
16	32089	7/24/91	22:03:32.4	70.5116	29.2224	1.63	E
20	35043	8/15/91	15:50:25.1	70.2630	29.0836	1.12	E
21	35828	8/21/91	12:23:41.7	70.4859	29.2854	1.48	E
22	35951	8/22/91	16:29:38.6	70.4374	29.3351	1.54	E
33	327337	5/8/92	11:18:20.3	70.3872	28.8075	1.39	E
34	328546	5/16/92	12:19:31.7	70.4271	28.7940	1.49	E
35	328447	5/20/92	17:08:13.8	70.2380	28.7945	1.24	E
37	329055	5/26/92	16:48:15.7	70.4186	28.6098	1.36	E
38	329811	6/5/92	08:43:46.8	70.4131	28.8663	1.25	E
39	330379	6/12/92	16:25:38.2	70.4218	28.7098	1.26	E
47	335230	8/6/92	11:05:34.9	70.4178	29.1547	1.22	E
50	335771	8/13/92	16:29:48.4	70.4740	28.8246	1.49	E
52	337289	8/28/92	14:42:25.8	70.4789	28.8898	1.67	E
54	338500	9/10/92	15:25:56.1	70.4562	29.1170	1.16	E
57	340667	10/2/92	15:48:26.6	70.4812	28.8109	1.34	E

Table 8: Sorted events for area 3

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
58	340876	10/6/92	14:47:47.9	70.4692	28.8481	1.52	E
60	341890	10/21/92	13:22:10.6	70.5623	29.0132	1.55	E
61	342365	10/23/92	14:57:03.0	70.4605	29.2049	1.53	E
63	342818	11/5/92	13:32:48.7	70.4101	29.1565	1.50	E
64	342819	11/5/92	13:51:15.4	70.2880	28.8026	1.36	E
65	343589	11/17/92	10:23:25.2	70.4144	29.1546	1.32	E
66	344171	11/23/92	15:09:10.3	70.3836	28.7808	1.48	E

Remarks:

- Five reference events are necessary to represent the different kinds of signals coming from this area.
- The area covered by the IMS event locations is about 50 x 50 km southeast of the mine.
- None of the sorted events was reported in the Helsinki bulletin.
- The reference event for group F is also the only event in that group from the data set. A study using all events available in the IMS2 database for this area without magnitude restrictions showed that several events with local magnitude lower than 0.7 were located further away from the array than the events from the Varanger mine. The reference event shows a particularly large local magnitude (2.26) with respect to the other events.

Mine and event locations:

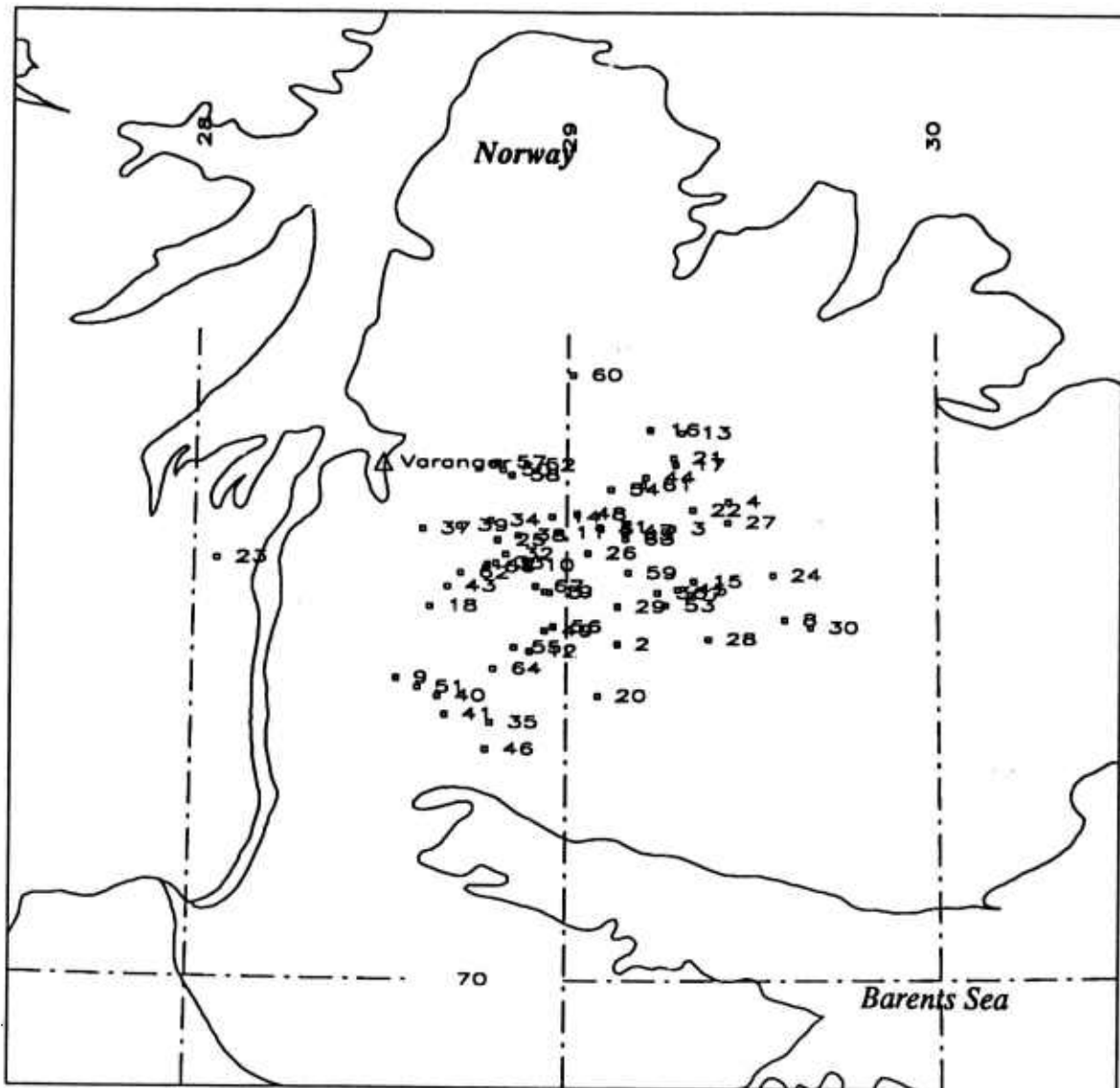


Figure 4: Mine and IMS event locations for area 3.

AREA 4

Latitude: 68 - 70°N

Longitude: 12 - 18°E

Local magnitude range: -

Number of events in IMS2: 26

Number of events within the magnitude range: 26

Number of processed events: 20

Frequency range used to process the data: 5 - 16 Hz

Processed signal length: 9s. before P, 84s. after P

Number of reference events: None

Reported mine locations:

Table 9: Mine locations for area 4

Label	Latitude °N	Longitude °E	Origin
JOG50	68.05	16.02	DMA
JOG51	68.47	16.05	DMA

Number of events found in the Helsinki bulletin: 2

Table 10: Events found in the Helsinki bulletin for area 4

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
8	315274	1/21/92	03:12:39.9	1.98	69.28	16.85	P.E.	-
13	336716	8/14/92	04:57:21.2	2.49	68.21	12.62	P.E.	-

Remarks:

- Most of these events have too low signal-to-noise ratios to be reliably Sorted. No groups can be clearly defined despite some similarities between events.
- The two events listed in the Helsinki bulletin have dissimilar waveforms but a high value of cross-correlation between envelopes (0.79).
- As shown on the map (Figure 5), these events are on average, separated by several tens of kilometers. The closest event to the mines is located 20 km away from JOG50, and 26 km away from JOG51. The next closest event is about 50 km away from both mines.

Mine and event locations:

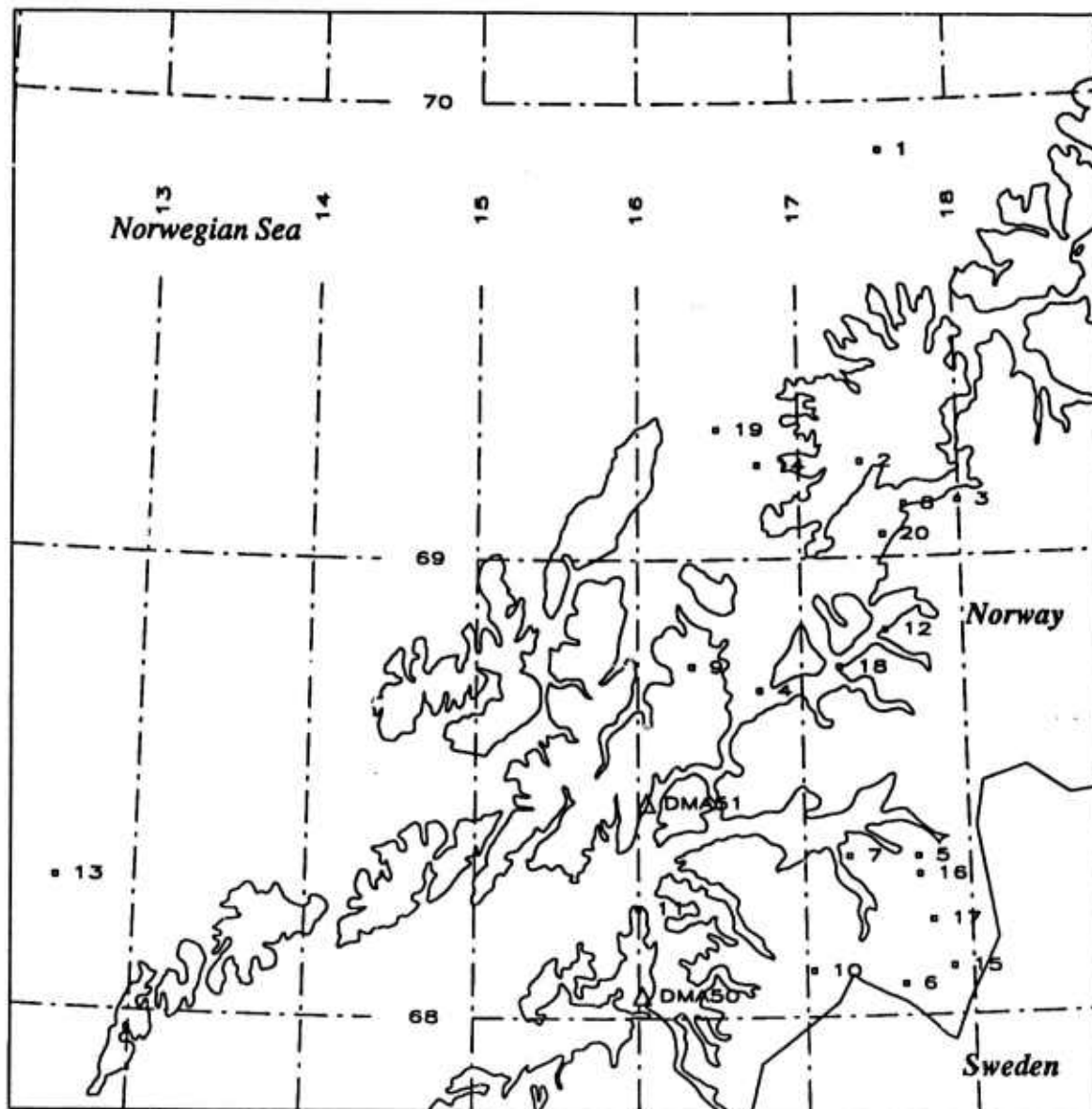


Figure 5: Mine and IMS event locations for area 4.

AREA 5

Latitude: 68 - 70°N

Longitude: 18 - 22°E

Local magnitude range: > 1.0

Reported mine locations: None

Number of events in IMS2: 488

Number of events within the magnitude range: 84

Number of processed events: 77

Number of events found in the Helsinki bulletin: None

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 6s. before P, 56s. after P

Number of reference events: 11

Table 11: Reference events for area 5

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
38	330571	1285342	2038377	0.97	A
8	15563	713115	509231	0.78	B
13	19809	754429	700376	0.81	C
21	28713	830250	949520	0.85	D
44	332265	1325099	2233138	0.81	E
63	341863	1482088	2779770	0.85	F
36	327541	1272339	2038056	0.80	G
15	22541	786887	777930	0.78	H
47	333552	1354925	2297137	0.80	I
27	35075	894218	1128149	0.79	J
9	16814	727497	554224	0.93	K

Events with the most reliable classification:

Table 12: Sorted events for area 5

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
38	330571	5/24/92	14:48:36.6	69.7824	21.9570	2.02	A
74	345521	12/14/92	06:52:14.6	69.8267	21.9523	1.50	A
8	15563	3/22/91	13:58:07.2	69.0184	18.4473	1.17	B

Table 12: Sorted events for area 5

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
20	27865	6/27/91	12:43:56.1	69.2248	20.0066	1.13	B
22	29057	7/5/91	13:04:06.2	69.0436	19.2764	1.06	B
23	29386	7/10/91	16:38:21.5	69.2672	18.7694	1.21	B
13	19809	4/25/91	08:06:51.0	68.0708	19.6921	1.09	C
32	322867	3/14/92	23:32:56.9	68.0127	21.0828	1.16	C
21	28713	7/2/91	13:44:15.4	68.9479	18.8104	1.03	D
24	31457	7/23/91	16:04:12.9	68.9784	18.7691	1.07	D
2	3371	11/23/90	23:33:04.3	68.0097	19.8211	1.38	E
4	314230	12/13/90	23:31:45.1	68.0664	21.4866	1.10	E
5	6911	12/29/90	23:37:00.3	68.0237	21.4833	1.09	E
12	19883	4/23/91	11:56:22.5	68.2348	20.2758	1.09	E
25	32058	7/25/91	22:34:05.2	68.0414	20.7979	1.09	E
37	327928	5/15/92	11:25:08.2	68.1048	21.1030	1.24	E
43	331849	6/28/92	22:33:09.3	68.0099	20.9676	1.00	E
44	332265	7/2/92	22:35:16.6	68.1002	21.5358	1.22	E
49	335966	8/15/92	22:37:26.2	68.0005	21.1932	1.20	E
41	333000	6/24/92	17:22:24.1	68.9170	18.4585	1.09	F
42	331727	6/26/92	17:24:16.0	68.9884	18.9885	1.07	F
53	337822	9/3/92	18:45:35.3	68.8783	18.8007	1.03	F
54	338319	9/9/92	16:42:55.2	68.9341	18.8506	1.04	F
55	339467	9/21/92	17:39:06.5	68.9612	18.7617	1.01	F
56	340397	9/29/92	16:15:42.9	68.8711	18.5368	1.12	F
57	340604	10/1/92	16:37:57.5	68.8890	18.4979	1.27	F
58	340868	10/6/92	12:13:45.6	68.7216	18.6367	1.07	F
61	341440	10/15/92	16:25:01.8	68.8841	18.7246	1.12	F
62	341477	10/16/92	10:59:42.7	68.8597	18.3946	1.27	F
63	341863	10/22/92	15:58:26.6	69.1203	18.7281	1.19	F
64	342163	10/23/92	11:38:54.7	68.8439	18.5075	1.06	F
65	342244	10/26/92	17:22:23.8	68.9514	18.6261	1.32	F
66	342347	10/28/92	16:34:19.6	68.9019	18.5917	1.08	F

Table 12: Sorted events for area 5

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
67	342421	10/29/92	17:11:11.6	69.3350	19.0822	1.08	F
69	342849	11/3/92	17:15:30.0	68.7969	18.5595	1.27	F
70	342753	11/4/92	14:22:35.7	68.9155	18.7836	1.32	F
71	344862	11/26/92	12:15:23.2	68.8727	18.4979	1.15	F
72	344546	11/27/92	17:30:23.6	68.8075	18.5179	1.20	F
36	327541	5/11/92	22:34:09.6	68.0209	21.7613	1.20	G
77	346587	12/27/92	23:33:19.8	68.0535	21.8726	1.11	G
7	13766	3/11/91	16:26:18.8	69.6598	20.6200	1.06	H
15	22541	5/16/91	19:22:19.9	69.7118	21.3908	1.09	H
19	27317	6/26/91	21:46:33.4	69.6323	20.6200	1.11	H
6	8484	1/23/91	06:52:21.0	68.4820	21.2664	1.17	I
46	332535	7/7/92	06:03:58.8	69.4330	20.9371	1.56	
47	333552	7/16/92	18:35:40.8	69.8253	20.2792	1.26	I
52	337486	8/31/92	13:48:53.2	69.8816	20.3230	1.06	I
14	21025	5/7/91	16:02:30.1	69.9819	20.4977	1.30	J
26	35026	8/15/91	13:24:35.9	69.9785	20.5957	1.34	J
27	35075	8/19/91	18:09:10.7	69.9372	20.5324	1.39	J
9	16814	4/5/91	11:43:48.6	69.6312	18.9392	1.22	K
30	39890	9/14/91	10:52:10.0	69.6494	18.9279	1.11	K

Remarks:

- Several clusters of events can be seen on the map (Figure 6).
- Events from group E (located on the South-East corner of the map) have origin times that cover several years while events from group F (West on the map) cover only several months starting in June 1992. Only 9 events were located in this area between November 1990 and the end of May 1992. From the same area, 29 events occurred between September and November 1992. Despite the absence of reported mines, the observations concerning events from group F may be related to an increase of the mining activity in this area.

Mine and event locations:

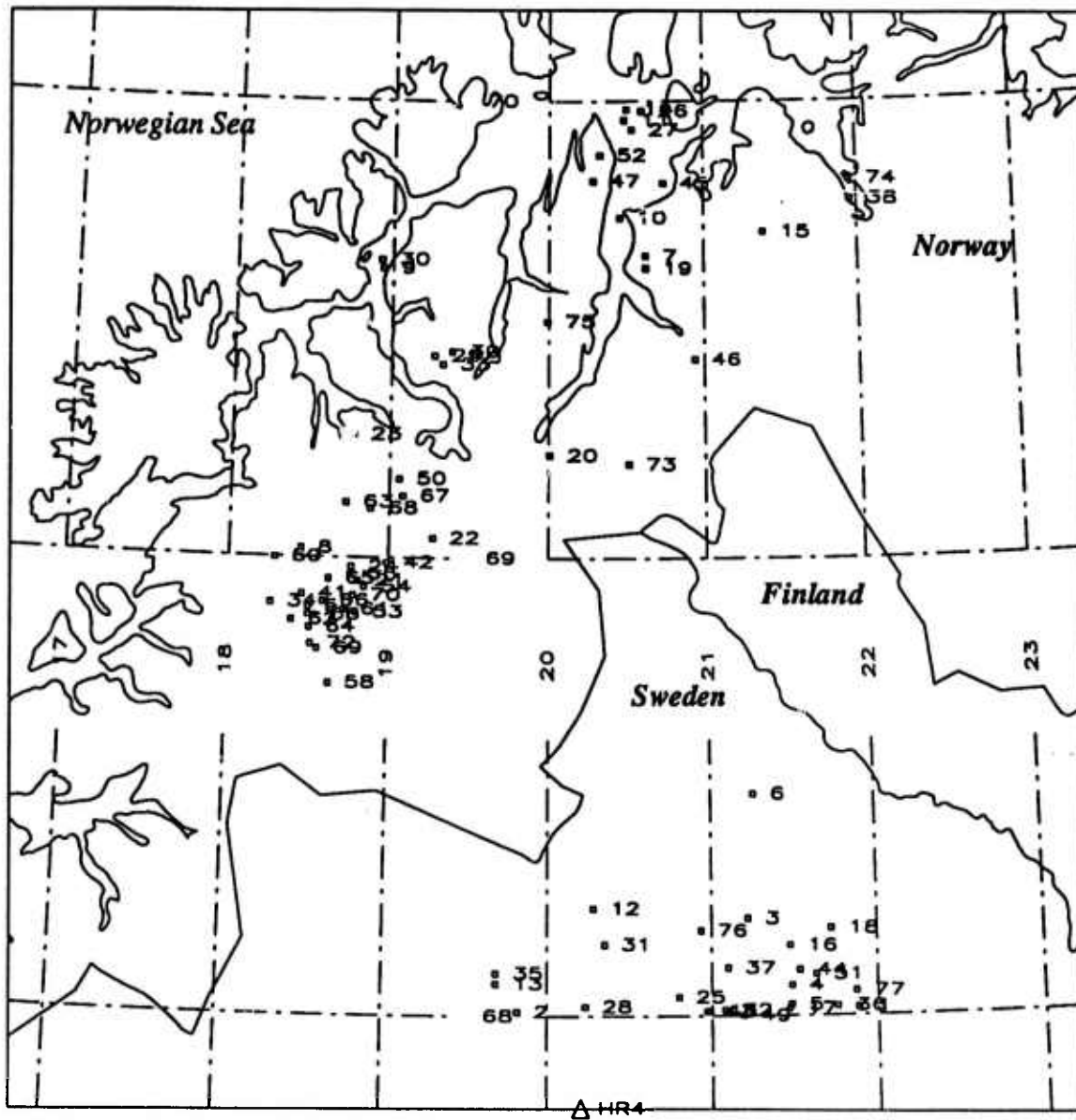


Figure 6: IMS event locations for area 5.

AREA 6

Latitude: 68 - 70°N

Longitude: 22 - 26°E

Local magnitude range: > 0.5

Reported mine locations: None

Number of events in IMS2: 196

Number of events within the magnitude range: 41

Number of processed events: 38

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 4s. before P, 39s. after P

Number of reference events: 3

Table 13: Reference events for area 6

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
15	302474	1009851	1510948	0.95	A
8	36875	903159	1149038	0.83	B
13	38132	925864	1205117	0.91	C

Number of events found in the Helsinki bulletin: 5

Table 14: Events found in the Helsinki bulletin for area 6

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
5	18004	4/13/91	21:18:33.9	2.28	69.29	24.08	P.E.	-
24	334923	7/18/92	13:51:12.4	2.13	68.39	25.52	EARTH.	-
15	302474	12/9/91	13:33:40.7	2.05	68.13	23.43	EARTH.	A
28	337339	8/29/92	09:15:01.8	1.44	68.0496	25.9575	-	C
29	337544	9/1/92	10:15:02.8	1.16	68.0599	25.6750	-	C

Events with the most reliable classification:

Table 15: Sorted events for area 6

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
15	302474	12/9/91	13:33:40.7	68.1606	23.8104	2.05	A
17	302716	12/5/91	04:21:36.0	68.2901	23.5691	0.84	A
8	36875	8/27/91	08:37:56.1	69.2194	22.6876	0.60	B

Table 15: Sorted events for area 6

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
9	36910	8/27/91	16:46:59.4	69.1511	22.4704	0.56	B
10	36524	8/30/91	13:33:22.3	69.0765	22.3266	0.68	B
11	37473	8/31/91	08:45:01.5	68.0077	25.8726	1.08	C
12	37683	9/3/91	09:21:02.1	68.0055	25.7938	1.24	C
13	38132	9/5/91	08:14:59.3	68.0005	25.9371	1.32	C
28	337339	8/29/92	09:15:01.8	68.0496	25.9575	1.44	C
29	337544	9/1/92	10:15:02.8	68.0599	25.6750	1.16	C

Remarks:

- Given the scattered locations of these events, the absence of reported mines, and the identification of two of these events as earthquakes made by the Finnish analysts, all these events are more likely to be earthquakes.

Mine and event locations:

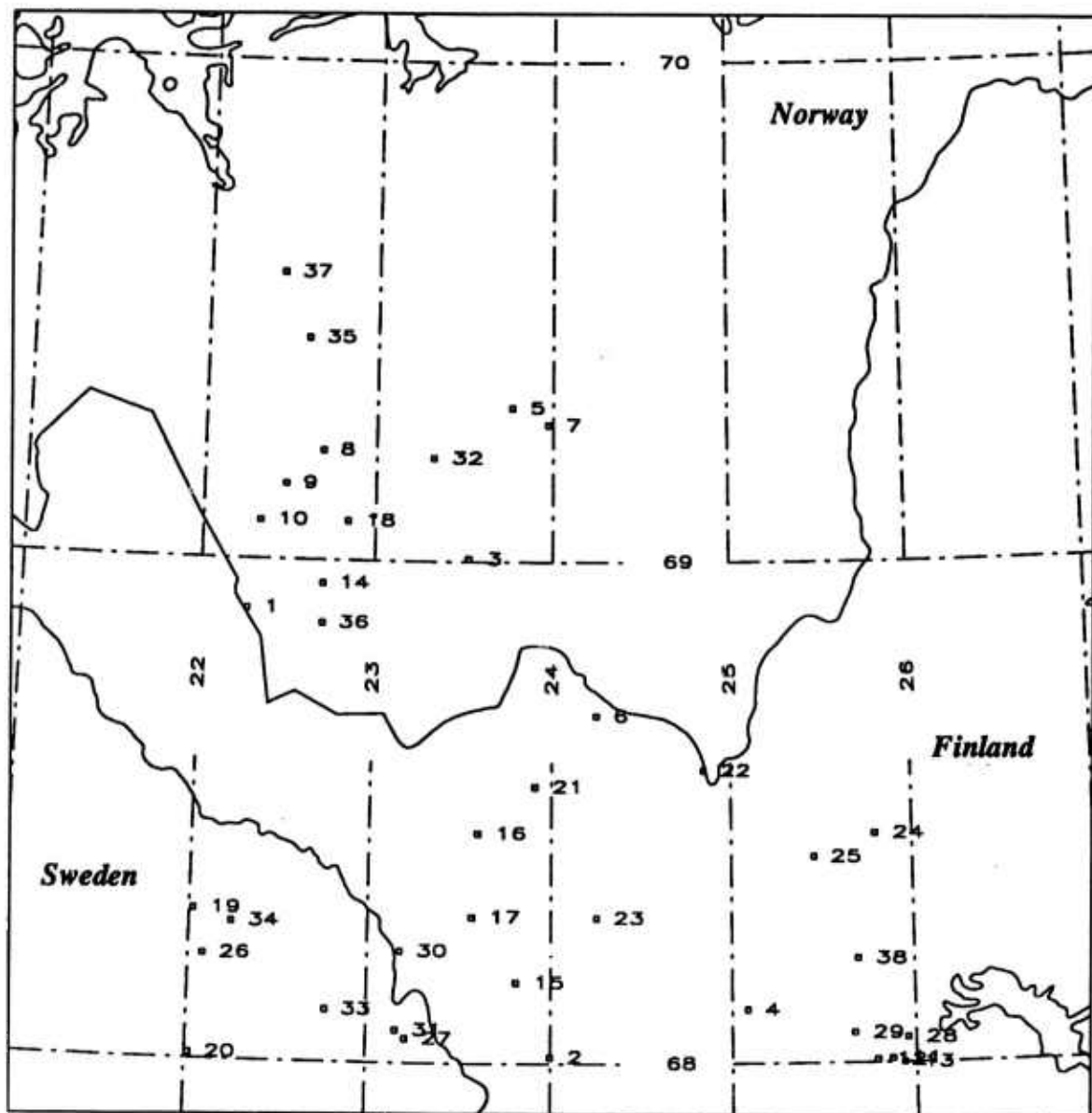


Figure 7: IMS event locations for area 6.

AREA 7

Latitude: 68 - 70°N

Longitude: 26 - 30°E

Local magnitude range: > 0.5

Number of events in IMS2: 113

Number of events within the magnitude range: 36

Number of processed events: 31

Frequency range used to process the data: 1 - 16 Hz

Processed signal length: 5s. before P, 45s. after P

Number of reference events: 3

Table 16: Reference events for area 7

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
13	301570	1006637	1421320	0.82	A
30	344716	1522802	2870538	0.77	B
4	8747	595924	1371904	0.81	C

Reported mine locations:

Table 17: Mine locations for area 7

Label	Latitude °N	Longitude °E	Origin
HF1	69.6	29.9	old_HELS
HN1	69.6	29.9	HELS

Number of events found in the Helsinki bulletin: 4

Table 18: Events found in the Helsinki bulletin for area 7

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
2	314336	12/19/90	12:34:54.2	1.96	HK3	EXP	-
10	300059	10/2/91	08:22:19.4	1.97	HN1	EXP.	A
13	301570	11/19/91	08:24:14.3	1.84	HN1	EXP.	A
21	335581	8/11/92	11:25:18.2	1.82	HN1	EXP.	B

Events with the most reliable classification:

Table 19: Sorted events for area 7

Event #	IMS orid	Origin time		IMS lat.	IMS lon.	IMS ml	Group
10	300059	10/2/91	08:22:19.4	69.5383	29.9079	1.97	A
13	301570	11/19/91	08:24:14.3	69.6760	29.9374	1.84	A
20	331971	6/30/92	06:50:41.5	69.5529	29.8912	1.82	A
22	336142	8/18/92	10:32:59.4	69.3202	29.9474	1.71	A
25	340933	10/7/92	12:33:57.6	69.5906	29.7712	1.86	A
19	331868	6/29/92	06:56:28.2	69.5603	29.9880	2.12	B
21	335581	8/11/92	11:25:18.2	69.5724	28.6357	1.82	B
24	340366	9/29/92	08:07:47.8	69.6056	28.6017	1.41	B
30	344716	12/1/92	11:13:08.7	69.5941	28.9453	2.12	B
31	346728	12/30/92	08:36:54.1	69.5365	29.9416	1.86	B
4	8747	1/24/91	12:19:31.0	69.8293	29.5233	0.52	C
7	20083	4/30/91	11:23:19.2	69.7730	29.2183	0.52	C
27	342389	10/29/92	09:09:41.7	69.1538	29.9561	0.88	C

Remarks:

- Only half of the processed events were reliably associated with one of the three groups. The other half consists of a few multiple events, and of events having dissimilar waveforms.

Mine and event locations:

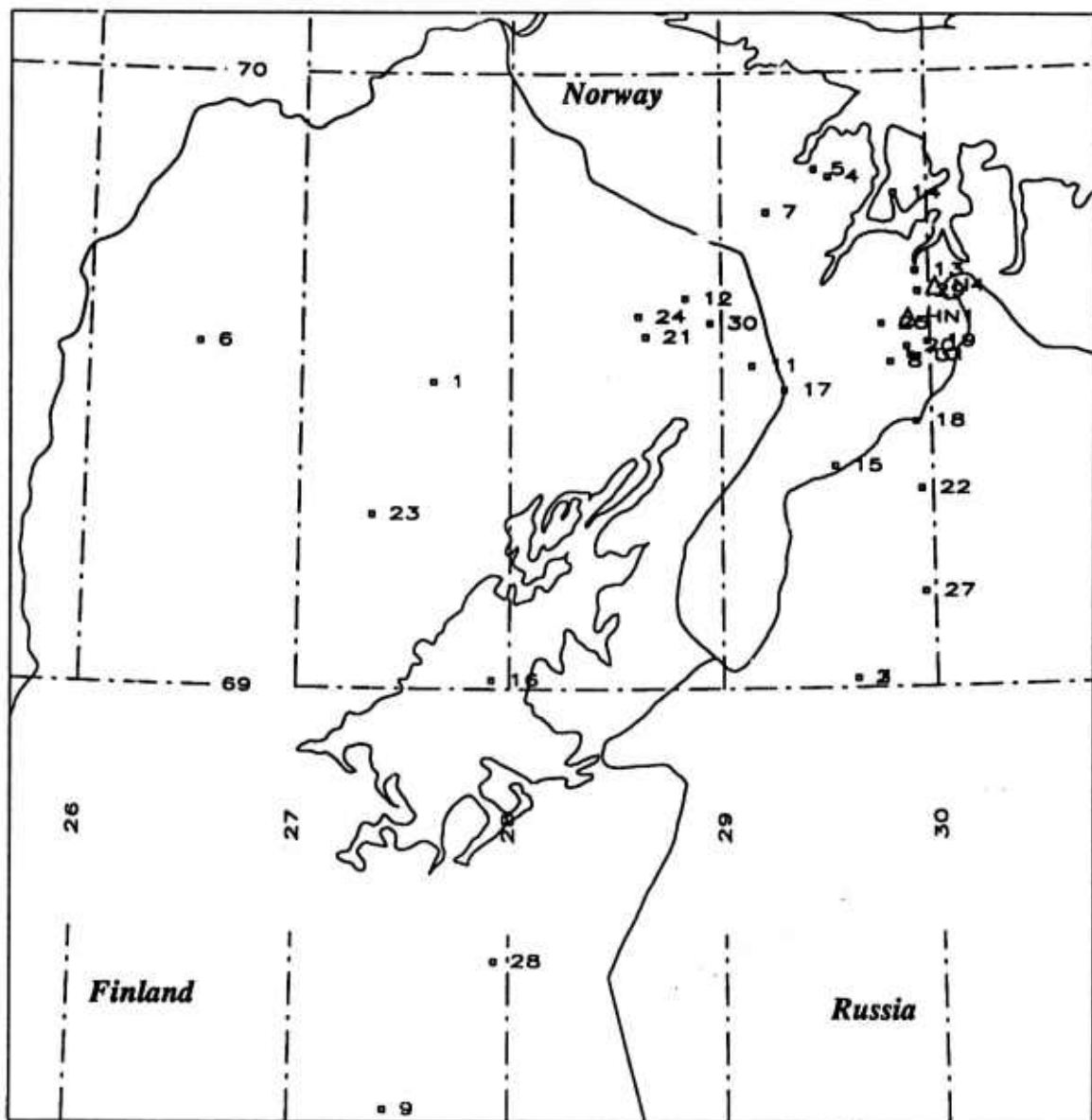


Figure 8: Mine and IMS event locations for area 7.

AREA 8

Latitude: 68 - 69°N

Longitude: 30 - 32°E

Local magnitude range: 0.5

Reported mine locations: None

Number of events in IMS2: 83

Number of events within the magnitude range: 56

Number of processed events: 51

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 8s. before P, 73s. after P

Number of reference events: 5

Table 20: Reference events for area 8

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
43	336069	1391753	2476339	0.79	A
35	331799	1323580	2212231	0.80	B
7	16175	727263	540296	0.84	C
46	340138	1448044	2716134	0.79	D
25	314771	1178241	1686210	0.79	E

Number of events found in the Helsinki bulletin: 2

Table 21: Events found in the Helsinki bulletin for area 8

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL label	Group
27	324417	4/10/92	10:08:25.2	1.40	HK1	EXP	A
35	331799	6/28/92	05:23:54.3	1.50	HK4	EXP	B

Events with the most reliable classification:

Table 22: Sorted events for area 8

Event #	IMS orid	Origin time		IMS lat	IMS lon	IMS ml	Group
24	313001	1/28/92	09:21:30.3	68.0797	31.7076	1.29	A
27	324417	4/10/92	10:08:25.2	68.2027	30.9844	1.40	A
28	324802	4/15/92	11:11:19.7	68.3303	31.1243	1.08	A
30	327073	5/6/92	06:36:47.5	68.0227	31.9220	0.96	A

Table 22: Sorted events for area 8

Event #	IMS orid	Origin time		IMS lat	IMS lon	IMS ml	Group
31	328976	5/26/92	06:55:12.2	68.1506	31.5145	1.20	A
32	329199	5/28/92	10:13:06.1	68.0118	31.6730	1.09	A
37	332429	7/5/92	10:21:57.9	68.0508	31.9934	2.02	A
38	332856	7/10/92	09:36:04.6	68.0340	31.6952	1.30	A
40	334020	7/22/92	00:39:36.2	68.2655	31.7353	0.79	A
43	336069	8/17/92	11:07:34.4	68.2146	31.2141	1.30	A
45	340137	9/25/92	10:36:25.8	68.1068	31.0948	0.84	A
49	343680	11/18/92	11:50:50.8	68.0527	30.8637	0.62	A
35	331799	6/28/92	05:23:54.3	68.2131	31.6495	1.50	B
39	333127	7/12/92	12:55:54.5	68.0445	31.8342	1.30	B
47	340652	10/2/92	12:35:50.1	68.0238	31.8404	1.69	B
7	16175	4/4/91	12:20:23.4	68.9245	31.5459	0.75	C
8	16183	4/4/91	14:08:30.3	68.8594	31.4075	0.59	C
9	16249	4/5/91	11:31:22.2	68.8563	31.8483	0.68	C
4	14133	3/18/91	04:12:39.4	68.0812	31.2102	0.56	D
5	15094	3/20/91	09:14:55.5	68.6318	31.9570	0.57	D
6	16645	3/29/91	10:35:00.7	68.6094	31.9555	0.72	D
10	16832	4/5/91	12:17:50.5	68.7257	31.6449	1.63	D
12	20053	4/26/91	14:08:47.5	68.8130	31.9610	0.65	D
16	30794	7/22/91	12:05:10.3	68.8158	30.9257	0.94	D
18	36579	8/28/91	04:19:49.0	68.8529	31.8363	0.86	D
34	329826	6/5/92	10:52:18.9	68.0912	30.5013	1.22	D
36	332163	7/2/92	07:03:05.3	68.9766	31.9547	0.76	D
41	334757	7/31/92	03:24:43.1	68.9833	31.6997	0.78	D
46	340138	9/25/92	10:43:43.4	68.8111	31.4930	1.11	D
48	342156	10/23/92	11:06:13.3	68.0369	31.7259	1.80	D
50	344712	12/1/92	10:31:03.6	68.9996	30.7156	0.97	D
3	9043	1/25/91	23:44:17.4	68.9273	30.3477	0.54	E
21	302085	11/30/91	13:54:48.1	68.9108	30.0423	0.70	E
22	302630	12/7/91	13:15:10.4	68.9549	30.1336	0.56	E

Table 22: Sorted events for area 8

Event #	IMS orid	Origin time		IMS lat	IMS lon	IMS ml	Group
25	314771	2/6/92	20:25:00.7	68.9498	30.0704	0.54	E
26	323020	3/30/92	17:57:35.8	68.9439	30.2489	0.55	E
33	329784	6/4/92	13:11:21.4	68.9879	30.1577	1.04	E
42	335086	8/4/92	13:21:59.9	68.8455	30.1376	0.51	E

Remarks:

- Two clusters of events can be seen on the location map (Figure 9). They consist of events from groups A and B for the southernmost cluster and of events from groups C, D and E for the northern cluster.
- The closest mines HK3, HK4, HK7 and HK 11 are located in areas 11, 9, 19 and 10 respectively at distances of about 50 km from the closest events.
- The events reported in the Helsinki bulletin have locations further east than the IMS locations. If the Helsinki locations are more accurate, there is an important bias in the IMS locations.

Mine and event locations:

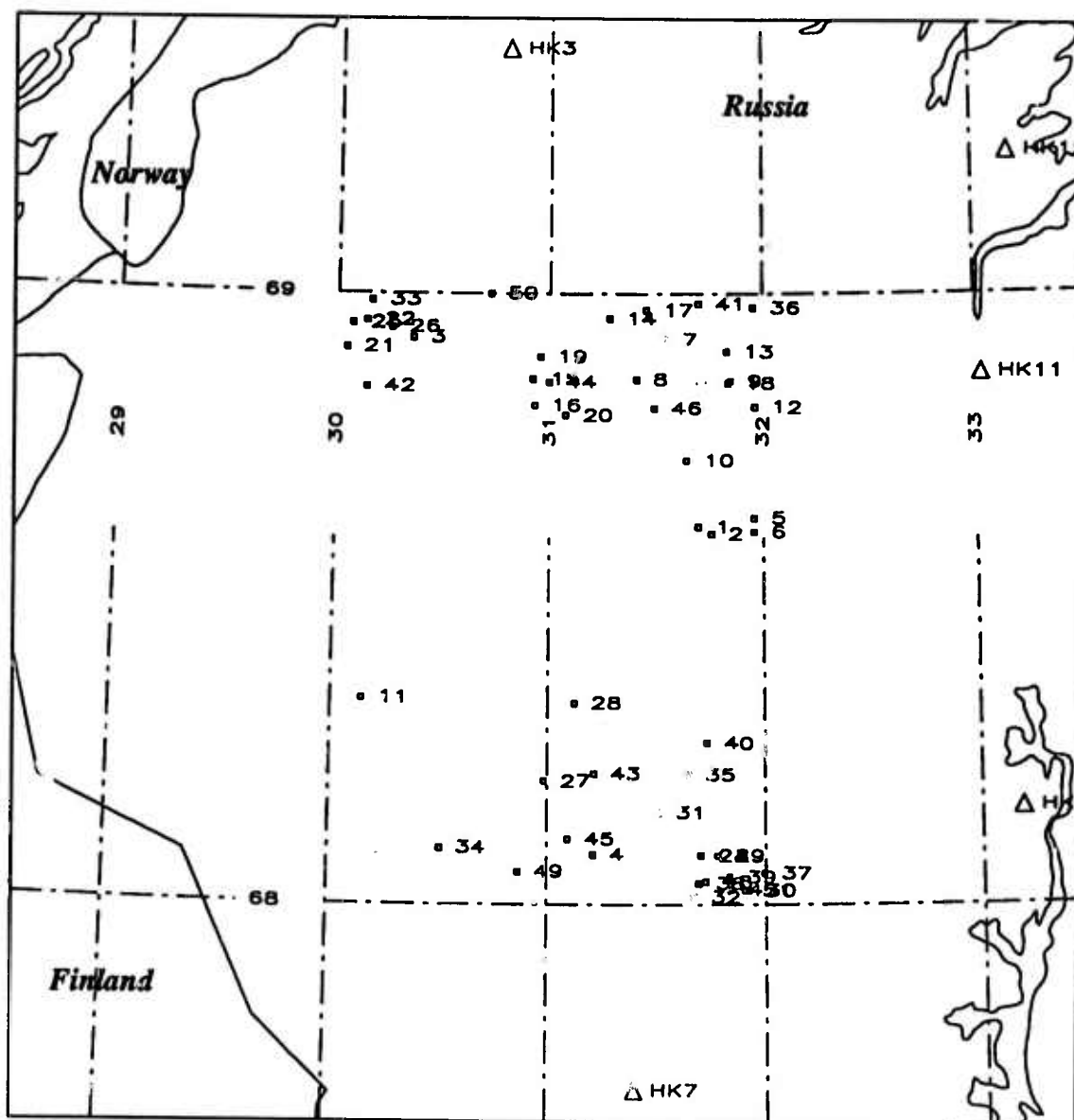


Figure 9: Mine and IMS event locations for area 8.

AREA 9

Latitude: 68 - 68.5°N

Longitude: 32 - 34°E

Local magnitude range: > 2.0

Number of events in IMS2: 230

Number of events within the magnitude range: 77

Number of processed events: 66

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 8s. before P, 68s. after P

Number of reference events: 6

Table 23: Reference events for area 9

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
13	20330	760536	735033	0.80	A
1	3014	518988	1350700	0.82	B
22	30603	848238	985523	0.8	C
29	302119	1008024	1451950	0.78	D
44	325195	1234330	1963734	0.82	E
48	333501	1354768	2295313	0.83	F

Reported mine locations:

Table 24: Mine locations for area 9

Label	Latitude °N	Longitude °E	Origin
SD39	68.040	33.229	SPOT
SD38	68.082	33.219	SPOT
HD6	68.1	33.2	old_HELS
SL	68.112	32.986	SPOT
SD35	68.120	33.400	SPOT
SD36	68.133	33.162	SPOT
JOG58	68.15	33.25	JOG
HK4	68.16	33.18	HELS
JOG59	68.25	33.27	JOG

Table 24: Mine locations for area 9

Label	Latitude °N	Longitude °E	Origin
SD34	68.251	33.267	SPOT
SD33	68.268	33.403	SPOT

Number of events found in the Helsinki bulletin: 51

Table 25: Events found in the Helsinki bulletin for area 9

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
15	23219	5/18/91	11:57:40.9	2.17	HD6		EXP	-
16	24309	5/25/91	11:01:19.8	2.13	HD6		EXP	-
17	24306	5/25/91	11:01:30.7	2.15	HD6		EXP	-
2	8102	11/24/90	11:32:46.2	2.13	HD6		EXP	-
20	26913	6/22/91	12:01:37.2	2.23	HK4		EXP	-
32	303116	12/28/91	13:02:27.3	2.07	HK4		EXP	-
7	6017	1/5/91	11:29:13.4	2.25	HD6		EXP	-
9	8742	1/24/91	11:47:24.7	2.13	HD6		EXP	A
13	20330	4/30/91	12:09:01.4	2.14	68.11	32.53	-	A
34	303577	12/26/91	11:33:57.2	2.19	HK4		EXP	A
42	324420	4/10/92	10:09:18.3	2.03	HK4		EXP	A
54	335830	8/14/92	10:25:50.9	2.20	HK4		EXP	A
1	3014	11/6/90	12:18:20.6	2.49	HD6		EXP	B
12	19005	4/18/91	12:59:05.0	2.31	HD6		EXP	B
35	303579	1/14/92	10:58:04.1	2.23	HK4		EXP	B
5	10053	11/29/90	12:59:56.1	2.29	HD6		EXP	C
14	22302	5/8/91	12:01:35.7	2.06	HD6		EXP	C
19	24940	6/1/91	11:18:00.2	2.12	HK5		EXP	C
22	30603	7/16/91	11:30:24.0	2.09	HK4		EXP	C
31	302724	12/5/91	10:13:00.0	2.27	HK4		EXP	C
33	303576	12/26/91	11:31:38.1	2.50	HK4		EXP	C
43	325090	4/17/92	10:01:19.7	2.23	HK4		EXP	C
46	330598	6/6/92	08:45:51.3	2.32	HK4		EXP	C

Table 25: Events found in the Helsinki bulletin for area 9

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
49	333608	7/17/92	10:14:50.7	2.19	68.11	32.89	-	C
24	35865	8/22/91	11:33:17.8	2.01	HK4		EXP	D
28	301636	11/14/91	12:52:21.3	2.03	HK4		EXP	D
29	302119	11/23/91	10:55:56.5	2.29	HK4		EXP	D
53	335815	8/14/92	08:03:37.5	2.44	HK4		EXP	D
55	337855	9/4/92	10:16:14.8	2.03	HK4		EXP	D
6	5212	12/22/90	11:28:03.1	2.27	68.12	32.59	-	E
8	316768	1/10/91	12:25:03.0	2.20	HD6		EXP	E
11	16659	3/29/91	11:57:16.1	2.02	HD6		EXP	E
18	24939	6/1/91	11:01:08.1	2.06	HK4		EXP	E
21	29261	7/6/91	11:22:13.9	2.11	HK4		EXP	E
23	31179	7/20/91	11:31:31.2	2.09	HK4		EXP	E
25	36498	8/24/91	11:27:31.6	2.14	HK4		EXP	E
26	300758	10/25/91	12:01:41.6	2.20	HK4		EXP	E
27	301391	11/6/91	12:50:02.5	2.40	HK4		EXP	E
30	302511	12/7/91	11:01:54.2	2.23	HK4		EXP	E
36	315459	2/1/92	09:47:03.4	2.00	HK4		EXP	E
38	316273	2/20/92	09:17:59.4	2.10	HK4		EXP	E
40	320032	3/9/92	09:19:30.6	2.03	HK4		EXP	E
41	321680	3/21/92	11:06:43.1	2.01	HK4		EXP	E
44	325195	4/18/92	09:56:45.1	2.07	HK4		EXP	E
45	326368	4/29/92	08:55:17.8	2.06	HK4		EXP	E
47	330602	6/6/92	10:16:43.9	2.36	HK4		EXP	E
50	334325	7/25/92	09:52:01.7	2.09	HK4		EXP	E
51	334859	8/1/92	10:10:35.6	2.13	HK4		EXP	E
56	338669	9/10/92	10:27:23.4	2.11	HK4		EXP	E
57	338626	9/12/92	10:51:49.0	2.07	HK4		EXP	E
10	10130	2/1/91	11:07:47.3	2.16	HD6		EXP	F
48	333501	7/16/92	10:19:18.4	2.12	68.09	33.09	-	F

Events with the most reliable classification:

Table 26: Sorted events for area 9

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
9	8742	1/24/91	11:47:24.7	68.1108	32.8434	2.13	A
13	20330	4/30/91	12:09:01.4	68.1934	32.6467	2.14	A
34	303577	12/26/91	11:33:57.2	68.0013	32.5579	2.19	A
37	314556	12/27/90	11:31:05.4	68.3407	33.2841	2.05	A
42	324420	4/10/92	10:09:18.3	68.0041	32.6148	2.03	A
54	335830	8/14/92	10:25:50.9	68.1056	32.9570	2.20	A
1	3014	11/6/90	12:18:20.6	68.0934	32.5025	2.49	B
12	19005	4/18/91	12:59:05.0	68.0319	32.9389	2.31	B
35	303579	1/14/92	10:58:04.1	68.0248	32.4510	2.23	B
5	10053	11/29/90	12:59:56.1	68.1241	32.7919	2.29	C
14	22302	5/8/91	12:01:35.7	68.3248	32.0255	2.06	C
19	24940	6/1/91	11:18:00.2	68.0251	32.9923	2.12	C
22	30603	7/16/91	11:30:24.0	68.2394	32.7902	2.09	C
31	302724	12/5/91	10:13:00.0	68.1593	33.0261	2.27	C
33	303576	12/26/91	11:31:38.1	68.0206	32.5903	2.50	C
43	325090	4/17/92	10:01:19.7	68.0334	32.6147	2.23	C
46	330598	6/6/92	08:45:51.3	68.1338	33.1541	2.32	C
49	333608	7/17/92	10:14:50.7	68.0545	32.1319	2.19	C
52	335227	8/6/92	10:17:50.8	68.1278	32.4300	2.42	C
61	344775	12/2/92	11:08:26.8	68.0763	32.9638	2.18	C
24	35865	8/22/91	11:33:17.8	68.0487	32.8397	2.01	D
28	301636	11/14/91	12:52:21.3	68.0380	33.2435	2.03	D
29	302119	11/23/91	10:55:56.5	68.0542	32.5747	2.29	D
53	335815	8/14/92	08:03:37.5	68.1547	33.2265	2.44	D
55	337855	9/4/92	10:16:14.8	68.0691	32.4737	2.03	D
58	340651	10/2/92	12:40:37.6	68.2149	32.7737	2.05	D
62	344962	12/3/92	10:25:33.9	68.1559	32.5389	2.47	D
64	346218	12/18/92	12:09:51.8	68.1122	33.1321	2.62	D

Table 26: Sorted events for area 9

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
6	5212	12/22/90	11:28:03.1	68.0453	32.7561	2.27	E
8	316768	1/10/91	12:25:03.0	68.0855	32.4765	2.20	E
11	16659	3/29/91	11:57:16.1	68.0427	32.4041	2.02	E
18	24939	6/1/91	11:01:08.1	68.0190	32.5212	2.06	E
21	29261	7/6/91	11:22:13.9	68.1005	32.3338	2.11	E
23	31179	7/20/91	11:31:31.2	68.1587	32.8559	2.09	E
25	36498	8/24/91	11:27:31.6	68.0488	32.6091	2.14	E
26	300758	10/25/91	12:01:41.6	68.0285	32.8665	2.20	E
27	301391	11/6/91	12:50:02.5	68.1162	33.1717	2.40	E
30	302511	12/7/91	11:01:54.2	68.0577	32.7845	2.23	E
36	315459	2/1/92	09:47:03.4	68.1287	32.9233	2.00	E
38	316273	2/20/92	09:17:59.4	68.1401	32.9917	2.10	E
39	321572	3/3/92	11:11:36.9	68.1202	33.0678	2.71	E
40	320032	3/9/92	09:19:30.6	68.0134	33.2149	2.03	E
41	321680	3/21/92	11:06:43.1	68.0302	33.5280	2.01	E
44	325195	4/18/92	09:56:45.1	68.0499	33.4924	2.07	E
45	326368	4/29/92	08:55:17.8	68.0831	32.7108	2.06	E
47	330602	6/6/92	10:16:43.9	68.1529	33.2488	2.36	E
50	334325	7/25/92	09:52:01.7	68.1250	33.4559	2.09	E
51	334859	8/1/92	10:10:35.6	68.0062	33.1945	2.13	E
56	338669	9/10/92	10:27:23.4	68.0505	32.9486	2.11	E
57	338626	9/12/92	10:51:49.0	68.0567	33.1630	2.07	E
59	341707	10/17/92	11:02:29.9	68.1366	33.0420	2.23	E
60	342801	11/5/92	11:29:33.1	68.0090	32.9639	2.43	E
63	345203	12/11/92	10:53:27.1	68.0842	32.9936	2.42	E
10	10130	2/1/91	11:07:47.3	68.1833	33.0490	2.16	F
48	333501	7/16/92	10:19:18.4	68.0304	32.7308	2.12	F
65	346171	12/23/92	10:43:39.2	68.1142	33.0272	2.48	F

Remarks:

- Figure 10 shows that the IMS event locations are systematically located too close to the ARCESS array with respect to the mine locations shown on the map.

Mine and event locations:

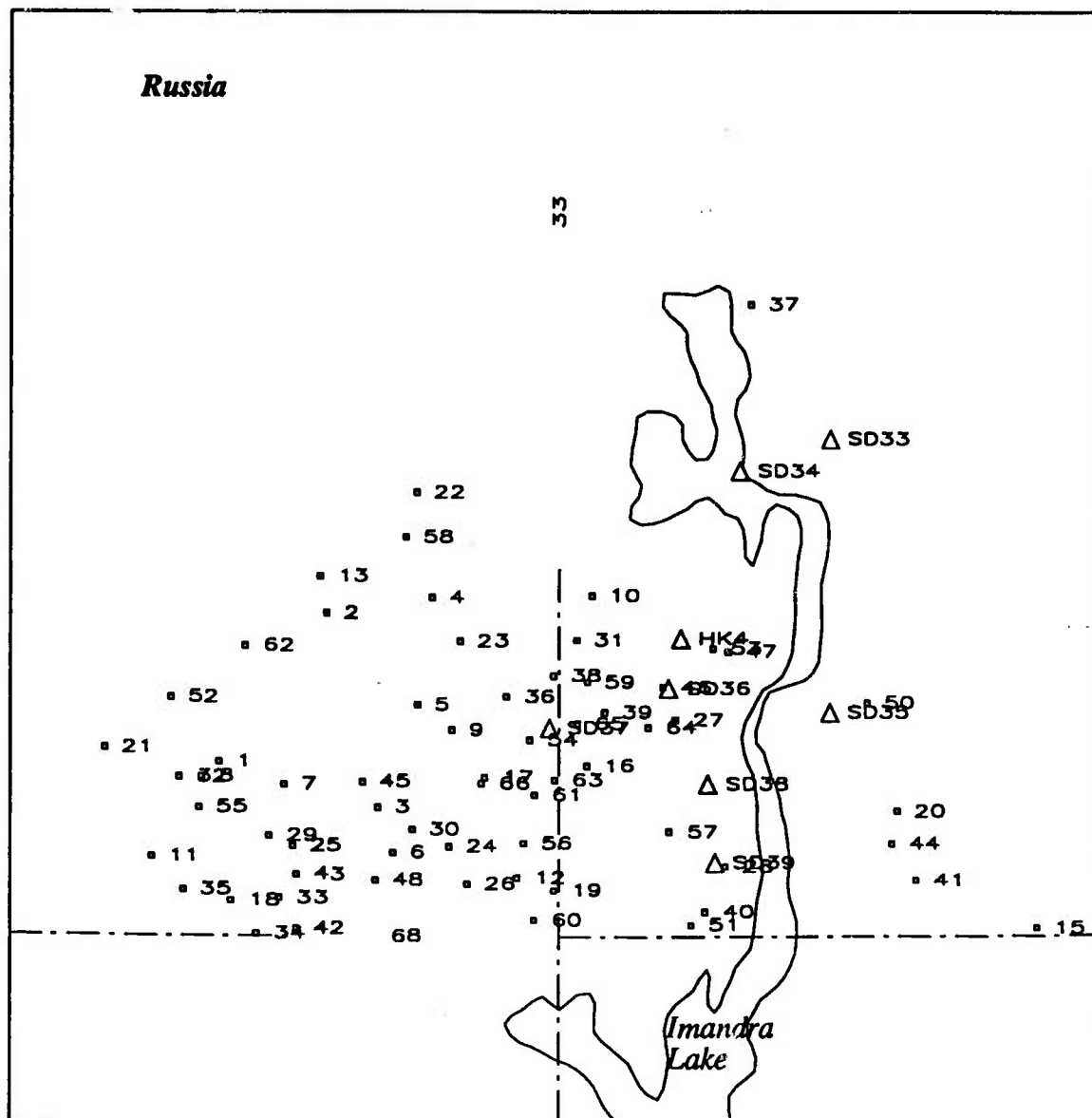


Figure 10: Mine and IMS event locations for area 9.

AREA 10

Latitude: 68.5 - 69°N

Longitude: 32 - 34°E

Local magnitude range: > 1.0

Number of events in IMS2: 129

Number of events within the magnitude range: 77

Number of processed events: 69

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 7s. before P, 61s. after P

Number of reference events: 11

Table 27: Reference events for area 10

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
40	300626	1003170	1344257	0.83	A
11	16067	720258	543398	0.84	B
42	312825	1030299	1595182	0.89	C
29	30828	849023	992066	0.90	D
60	331691	1323165	2206447	0.91	E
8	14379	704395	483826	0.85	F
3	7015	566251	1365163	0.84	G
35	36093	897783	1141049	0.84	H
33	34142	879848	1097771	0.86	I
38	41745	956660	1284134	0.83	J
68	345142	1527877	2882856	0.88	K

Reported mine locations:

Table 28: Mine locations for area 10

Label	Latitude °N	Longitude °E	Origin
JOG62	68.69	33.11	JOG
SD32	68.700	33.125	SPOT
SD31	68.791	33.146	SPOT
SD30	68.792	33.133	SPOT
HD5	68.8	33.0	old_HELS

Table 28. Mine locations for area 10

Label	Latitude °N	Longitude °E	Origin
JOG64	68.87	33.02	JOG
HK11	68.87	33.03	HELS
SD29	68.872	33.025	SPOT
JOG65	68.93	33.08	JOG
SD28	68.930	33.096	SPOT
SD27	68.943	32.965	SPOT
SD26	68.997	32.871	SPOT
SD25	68.999	32.910	SPOT

Number of events found in the Helsinki bulletin: 6

Table 29: Events found in the Helsinki bulletin for area 10

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
30	31063	7/19/91	14:09:20.1	1.28	HK6		EXP	-
40	300626	10/29/91	15:27:02.1	1.59	HK11		EXP	A
11	16067	3/29/91	04:00:09.2	1.32	HD7		EXP	B
60	331691	6/26/92	10:39:58.7	1.39	HK11		EXP	E
38	41745	9/27/91	03:59:25.4	1.39	69.32	33.14	-	J
7	10106	2/1/91	09:56:59.2	1.85	HD7		EXP	K

Events with the most reliable classification:

Table 30: Sorted events for area 10

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
2	314126	12/12/90	12:45:21.6	68.7715	32.1792	1.38	A
12	17463	4/9/91	14:26:11.8	68.5887	32.4897	1.52	A
34	34690	8/8/91	15:50:05.3	68.6584	32.4886	1.52	A
40	300626	10/29/91	15:27:02.1	68.6345	33.1451	1.59	A
49	321702	3/6/92	14:59:33.4	68.5324	32.6953	1.33	A
54	323552	3/27/92	15:00:04.3	68.6074	32.5914	1.47	A
1	8307	11/26/90	12:49:26.1	68.7582	32.2233	1.22	B

Table 30: Sorted events for area 10

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
5	8513	1/23/91	13:08:48.0	68.7699	32.4519	1.22	B
11	16067	3/29/91	04:00:09.2	68.9605	32.5207	1.32	B
13	17831	4/12/91	04:00:09.1	68.9041	32.2265	1.21	B
15	19757	4/25/91	03:57:24.1	68.8918	32.4924	1.27	B
27	28216	7/3/91	03:58:20.9	68.8507	32.4183	1.34	B
46	315585	2/4/92	11:27:08.3	68.7665	32.4565	1.42	B
50	320047	3/9/92	13:35:08.9	68.9313	32.8643	1.51	B
57	326472	4/8/92	03:11:34.8	68.9602	32.5605	1.17	B
9	14917	3/19/91	11:55:11.2	68.9924	32.3357	1.19	C
42	312825	12/27/91	11:10:59.6	68.8949	32.5424	1.22	C
56	325642	4/2/92	14:21:50.5	68.9111	32.6140	1.20	C
19	22737	5/14/91	03:59:31.4	68.8652	32.3025	1.13	D
25	27652	6/18/91	03:55:16.5	68.8607	32.4419	1.04	D
29	30828	7/17/91	03:59:46.9	68.8617	32.7175	1.40	D
36	38246	9/10/91	04:06:21.2	68.8700	32.2555	1.33	D
43	311924	1/9/92	15:47:57.1	68.5647	32.3529	1.33	D
45	313648	1/28/92	12:33:14.6	68.9137	32.3189	1.34	D
64	339495	9/22/92	03:11:44.0	68.7818	32.2639	1.23	D
51	320316	3/11/92	12:07:11.6	68.7842	32.4499	1.26	E
59	325573	4/23/92	11:58:53.9	68.8192	32.3994	1.41	E
60	331691	6/26/92	10:39:58.7	68.8217	32.3637	1.39	E
66	342803	11/5/92	11:25:43.6	68.7747	32.5809	1.22	E
6	10033	1/31/91	12:48:42.8	68.7419	32.3917	1.45	F
8	14379	3/13/91	12:26:47.1	68.6820	32.5310	1.42	F
16	19845	4/25/91	12:36:03.6	68.8367	32.5387	1.09	F
28	28953	7/4/91	12:29:35.2	68.9393	32.6537	1.09	F
3	7015	12/28/90	09:58:29.5	68.8679	32.7613	1.54	G
4	11189	1/18/91	10:01:12.4	68.6815	33.3106	1.54	G
39	41760	9/27/91	10:00:23.2	68.8250	32.7691	1.49	G
41	303197	12/20/91	11:39:10.4	68.8814	32.6514	1.42	G

Table 30: Sorted events for area 10

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
14	17744	4/16/91	04:07:15.0	68.9114	32.3066	1.08	H
32	34085	8/7/91	04:00:19.3	68.5754	32.5251	1.14	H
35	36093	8/23/91	04:03:21.7	68.5925	32.6554	1.41	H
24	25880	6/7/91	12:18:19.4	68.7914	32.5562	1.05	I
33	34142	8/7/91	12:33:39.3	68.8711	32.4831	1.35	I
63	337950	8/26/92	10:41:46.9	68.6490	32.4015	1.24	I
65	341410	10/15/92	11:42:57.4	68.7151	32.4577	1.07	I
10	15436	3/22/91	03:59:15.7	68.8590	32.4801	1.15	J
21	23026	5/17/91	04:00:43.4	68.7359	32.5636	1.49	J
22	24781	5/31/91	03:55:27.2	68.9694	32.6038	1.28	J
23	25810	6/7/91	03:57:44.6	68.8822	32.0490	1.08	J
38	41745	9/27/91	03:59:25.4	68.9312	32.6721	1.39	J
47	315692	2/4/92	13:06:40.9	68.9545	32.2187	1.28	J
52	324153	3/25/92	14:36:58.7	68.7387	32.3526	1.28	J
58	325377	4/21/92	11:41:01.4	68.8199	32.2844	1.24	J
7	10106	2/1/91	09:56:59.2	68.7802	32.8438	1.85	K
26	27547	6/28/91	09:58:22.9	68.9607	32.6514	1.49	K
37	40640	9/20/91	09:55:23.6	68.8705	32.8023	1.52	K
48	321570	3/3/92	09:59:48.7	68.7385	32.5345	1.24	K
53	323165	3/27/92	09:57:57.4	68.7585	32.4849	1.50	K
55	323139	3/31/92	09:09:39.0	68.8690	32.6641	1.46	K
67	343867	11/20/92	09:58:34.7	68.9689	32.1329	1.19	K
68	345142	12/8/92	10:05:54.0	68.8444	33.8826	1.70	K
69	346644	12/29/92	09:59:42.2	68.9428	32.5805	1.58	K

Remarks:

- Figure 11 shows that the IMS event locations are systematically located too close to the ARCESS array with respect to the mine locations shown on the map.

Mine and event locations:

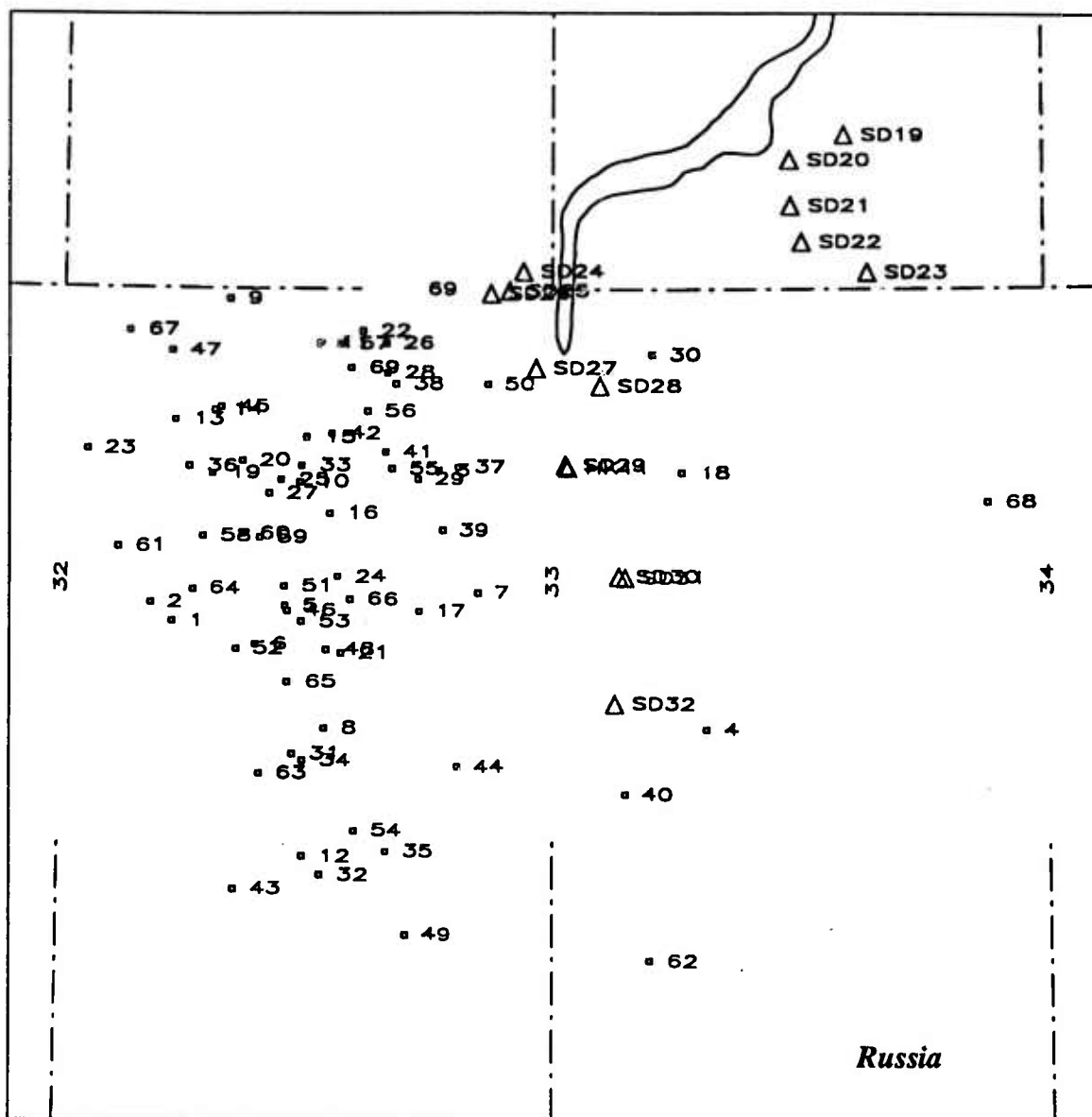


Figure 11: Mine and IMS event locations for area 10.

AREA 11

Latitude: 69 - 70°N

Longitude: 30 - 31°E

Local magnitude range: > 2.0

Number of events in IMS2: 1091

Number of events within the magnitude range: 167

Number of processed events: 126

Frequency range used to process the data: 1 - 16 Hz

Processed signal length: 6s. before P, 51s. after P

Number of reference events: 6

Table 31: Reference events for area 11

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
125	347014	1558405	2888898	0.76	A
40	34154	880033	1098200	0.77	B
18	12932	621250	1376344	0.67	C
83	325993	1230655	1907025	0.81	D
41	35098	883272	1124174	0.8	E
97	331516	1320180	2198758	0.78	F

Reported mine locations:

Table 32: Mine locations for area 11

Label	Latitude °N	Longitude °E	Origin
SD4	69.329	30.019	SPOT
SD2	69.367	30.093	SPOT
SD3	69.368	30.134	SPOT
JOG67	69.39	30.33	JOG
SD7	69.398	30.614	SPOT
HD2	69.40	30.80	old_HELs
HK3	69.40	30.80	HELs
SD8	69.401	30.847	SPOT
SD9	69.409	30.953	SPOT
JOG66	69.42	30.28	JOG

Table 32: Mine locations for area 11

Label	Latitude °N	Longitude °E	Origin
N400	69.42	30.80	NORW
SD6	69.432	30.527	SPOT
SD5	69.435	30.531	SPOT
SD1	69.597	30.049	SPOT
N4	69.65189	30.02533	NORW

Number of events found in the Helsinki bulletin: 101

Table 33: Events found in the Helsinki bulletin for area 11

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
80	321808	3/20/92	12:59:42.6	2.33	HK3		EXP	-
11	7120	12/28/90	12:37:29.2	2.57	HK3		EXP	A
25	20047	4/26/91	12:39:06.4	2.20	HK3		EXP	A
60	303237	12/21/91	13:18:06.7	2.05	HK3		EXP	A
14	9389	1/29/91	12:43:08.7	2.26	HN1		EXP	B
32	26119	6/12/91	07:13:03.1	2.05	HN1		EXP	B
40	34154	8/7/91	14:25:23.8	2.26	HN1		EXP	B
56	301510	11/18/91	08:29:32.5	2.04	HN1		EXP	B
17	12931	2/6/91	12:31:43.7	2.78	HK3		EXP	C
18	12932	2/6/91	12:31:59.0	2.84	HK3		EXP	C
37	32930	7/31/91	12:44:07.2	2.20	HK3		EXP	C
100	332889	7/10/92	11:34:29.1	2.16	HK3		EXP	C
106	336573	8/21/92	11:13:52.5	2.27	HK3		EXP	C
108	337866	9/4/92	11:28:17.8	2.69	HK3		EXP	C
111	340165	9/25/92	12:11:26.2	2.44	HK3		EXP	C
3	4979	11/13/90	12:01:14.6	2.02	HN1		EXP	D
7	300017	12/7/90	10:37:32.2	2.16	HN1		EXP	D
19	13486	3/7/91	11:57:42.1	2.63	HN1		EXP	D
28	21152	5/2/91	07:27:28.4	2.29	HN1		EXP	D
43	34674	8/13/91	06:57:53.6	2.26	69.63	30.19	-	D

Table 33: Events found in the Helsinki bulletin for area 11

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
75	321605	3/3/92	23:00:49.3	2.22	HN1	EXP	D
78	322300	3/13/92	08:14:15.2	2.00	HN1	EXP	D
83	325993	4/6/92	07:21:30.4	2.25	HK3	EXP	D
41	35098	8/9/91	12:52:23.4	2.56	HK3	EXP	E
4	5887	11/16/90	12:32:16.1	2.18	HK3	EXP	F
5	5888	11/16/90	12:33:31.4	3.03	HK3	EXP	F
6	9501	11/28/90	12:30:03.0	2.48	HK3	EXP	F
8	313956	12/7/90	12:52:18.0	2.29	HK3	EXP	F
9	4357	12/19/90	12:36:18.0	2.25	HK3	EXP	F
10	9601	12/21/90	12:12:13.7	2.61	HK3	EXP	F
12	319822	1/11/91	12:26:05.5	2.64	HK3	EXP	F
13	11206	1/18/91	12:45:54.8	2.40	HK3	EXP	F
15	10038	1/31/91	12:55:46.1	2.45	HK3	EXP	F
16	10157	2/1/91	12:50:27.4	2.39	HK3	EXP	F
20	15120	3/20/91	12:59:14.5	2.36	HK3	EXP	F
21	15119	3/20/91	12:56:47.5	2.43	HK3	EXP	F
22	16662	3/29/91	12:48:24.2	2.22	HK3	EXP	F
23	16831	4/5/91	12:12:42.1	2.32	HK3	EXP	F
24	17743	4/10/91	12:25:08.5	2.26	HK3	EXP	F
26	20049	4/26/91	12:39:52.3	2.32	HK3	EXP	F
27	20449	4/30/91	12:34:46.5	3.44	HK3	EXP	F
29	24872	5/31/91	12:39:13.9	2.41	HK3	EXP	F
30	25681	6/5/91	12:30:59.7	2.28	HK3	EXP	F
31	25884	6/7/91	12:46:20.9	2.19	HK3	EXP	F
33	29048	7/5/91	12:20:10.9	2.35	HK3	EXP	F
34	29049	7/5/91	12:21:01.0	2.47	HK3	EXP	F
35	30841	7/17/91	12:18:36.7	2.38	HK3	EXP	F
36	31701	7/24/91	12:30:58.2	2.36	HK3	EXP	F
39	32971	7/31/91	13:30:04.5	2.38	HK3	EXP	F
44	35829	8/21/91	12:43:12.3	2.62	HK3	EXP	F

Table 33: Events found in the Helsinki bulletin for area 11

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
45	37564	8/30/91	12:22:24.6	2.37	HK3	EXP	F
47	38374	9/6/91	14:11:15.0	2.42	HK3	EXP	F
48	39500	9/13/91	12:25:51.5	2.64	HK3	EXP	F
49	40446	9/18/91	12:30:33.7	2.76	HK3	EXP	F
50	41779	9/27/91	12:16:16.4	2.93	HN1	EXP	F
51	300147	10/2/91	13:45:28.2	2.49	HK3	EXP	F
52	300489	10/18/91	13:04:50.5	2.10	HK3	EXP	F
53	300783	10/25/91	13:58:56.4	2.75	HK3	EXP	F
54	300786	10/25/91	14:02:23.1	2.49	HK3	EXP	F
55	301140	11/1/91	13:15:45.2	2.65	HK3	EXP	F
57	301995	11/22/91	14:02:42.1	2.52	HK3	EXP	F
61	303238	12/21/91	13:18:28.6	2.37	HK3	EXP	F
62	312845	12/27/91	13:30:08.8	2.63	HK3	EXP	F
63	312882	12/29/91	14:04:49.4	2.54	HK3	EXP	F
64	313708	1/17/92	13:23:56.6	2.49	HK3	EXP	F
65	313709	1/17/92	13:26:25.2	2.66	HK3	EXP	F
66	312843	12/27/91	13:29:10.2	2.61	HK3	EXP	F
67	315362	1/31/92	12:29:55.9	2.47	HK3	EXP	F
68	315447	2/6/92	12:21:00.9	2.14	HK3	EXP	F
69	319425	2/21/92	12:50:11.2	2.16	HK3	EXP	F
70	319426	2/21/92	12:51:02.8	2.46	HK3	EXP	F
71	320982	2/28/92	12:45:11.0	2.52	HK3	EXP	F
72	318098	2/28/92	12:48:20.2	2.22	HK3	EXP	F
73	320988	2/28/92	12:48:57.1	2.30	HK3	EXP	F
74	319359	2/19/92	12:25:03.0	2.09	HK3	EXP	F
76	321681	3/6/92	12:09:46.5	2.27	HK3	EXP	F
77	320320	3/11/92	12:47:03.8	2.13	HK3	EXP	F
79	321023	3/18/92	12:57:45.3	2.34	HK3	EXP	F
84	326510	4/8/92	11:38:22.0	2.50	HN1	EXP	F
85	324432	4/10/92	11:29:51.2	2.24	HK3	EXP	F

Table 33: Events found in the Helsinki bulletin for area 11

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
86	326482	4/20/92	11:17:11.1	2.13	HK3	EXP	F
87	325462	4/22/92	11:03:30.7	2.15	HK3	EXP	F
88	326393	4/29/92	11:33:56.3	2.34	HK3	EXP	F
89	326396	4/29/92	11:37:50.4	2.03	HK3	EXP	F
90	328716	5/22/92	11:28:34.3	2.20	HK3	EXP	F
91	328721	5/22/92	11:30:12.4	2.19	HK3	EXP	F
92	329123	5/27/92	11:24:10.8	2.52	HK3	EXP	F
93	329664	6/3/92	11:42:25.6	2.35	HK3	EXP	F
94	330611	6/10/92	11:46:32.9	2.71	HK3	EXP	F
95	331070	6/19/92	11:31:26.8	2.39	HK3	EXP	F
96	331074	6/19/92	11:35:40.4	2.66	HK3	EXP	F
97	331516	6/24/92	11:33:29.5	2.74	HK3	EXP	F
99	333069	7/3/92	11:32:54.2	2.52	HK3	EXP	F
101	332890	7/10/92	11:35:05.3	2.40	HK3	EXP	F
102	333624	7/17/92	11:32:03.4	2.11	HK3	EXP	F
103	335324	8/7/92	11:54:39.6	2.12	HK3	EXP	F
104	335847	8/14/92	12:03:57.4	2.41	HK3	EXP	F
105	336568	8/21/92	11:05:06.6	2.27	HK3	EXP	F
107	336574	8/21/92	11:14:26.6	2.49	HK3	EXP	F
109	340517	9/23/92	11:37:02.4	2.62	HK3	EXP	F
110	340518	9/23/92	11:38:19.9	2.32	HK3	EXP	F

Events with the most reliable classification:

Table 34: Sorted events for area 11

Events #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
11 ^a	7120	12/28/90	12:37:29.2	69.2538	30.6467	2.57	A
25 ^a	20047	4/26/91	12:39:06.4	69.2606	30.7741	2.20	A
60 ^a	303237	12/21/91	13:18:06.7	69.3930	30.6859	2.05	A
125 ^a	347014	12/30/92	15:05:25.1	69.3397	30.6507	2.74	A

Table 34: Sorted events for area 11

Events #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
126 ^a	347015	12/30/92	15:05:46.4	69.3380	30.5784	2.46	A
14	9389	1/29/91	12:43:08.7	69.6587	30.1968	2.26	B
32	26119	6/12/91	07:13:03.1	69.6107	30.4195	2.05	B
40	34154	8/7/91	14:25:23.8	69.6221	30.0318	2.26	B
56	301510	11/18/91	08:29:32.5	69.6956	30.3512	2.04	B
113	341249	10/13/92	11:13:28.5	69.5759	30.2395	2.27	B
17 ^a	12931	2/6/91	12:31:43.7	69.3638	30.6756	2.78	C
18 ^a	12932	2/6/91	12:31:59.0	69.3691	30.4851	2.84	C
37	32930	7/31/91	12:44:07.2	69.3469	30.4185	2.20	C
38	32929	7/31/91	12:44:13.8	69.1590	30.6436	2.18	C
100 ^a	332889	7/10/92	11:34:29.1	69.3322	30.6006	2.16	C
106 ^a	336573	8/21/92	11:13:52.5	69.3479	30.4259	2.27	C
108 ^a	337866	9/4/92	11:28:17.8	69.2311	30.3954	2.69	C
111 ^a	340165	9/25/92	12:11:26.2	69.2701	30.5835	2.44	C
3	4979	11/13/90	12:01:14.6	69.7388	30.1614	2.02	D
7	300017	12/7/90	10:37:32.2	69.5239	30.1929	2.16	D
19	13486	3/7/91	11:57:42.1	69.6809	30.3511	2.63	D
28	21152	5/2/91	07:27:28.4	69.6532	30.3381	2.29	D
43	34674	8/13/91	06:57:53.6	69.5829	30.4252	2.26	D
75	321605	3/3/92	23:00:49.3	69.6701	30.2861	2.22	D
78	322300	3/13/92	08:14:15.2	69.5656	30.2532	2.00	D
83	325993	4/6/92	07:21:30.4	69.6856	30.0971	2.25	D
1	3020	11/6/90	12:49:22.7	69.6288	30.6558	2.67	E
41 ^a	35098	8/9/91	12:52:23.4	69.4258	30.9388	2.56	E
42 ^a	35099	8/9/91	12:52:26.7	69.1910	30.9533	2.48	E
2	3021	11/6/90	12:49:50.4	69.3806	30.6441	3.04	F
4	5887	11/16/90	12:32:16.1	69.1863	30.5353	2.18	F
5	5888	11/16/90	12:33:31.4	69.2823	30.6824	3.03	F
6	9501	11/28/90	12:30:03.0	69.2776	30.6470	2.48	F
8	313956	12/7/90	12:52:18.0	69.3863	30.8271	2.29	F

Table 34: Sorted events for area 11

Events #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
9	4357	12/19/90	12:36:18.0	69.4311	30.5819	2.25	F
10	9601	12/21/90	12:12:13.7	69.2421	30.6326	2.61	F
12	319822	1/11/91	12:26:05.5	69.2688	30.4799	2.64	F
13	11206	1/18/91	12:45:54.8	69.4242	30.4699	2.40	F
15	10038	1/31/91	12:55:46.1	69.3634	30.9905	2.45	F
16	10157	2/1/91	12:50:27.4	69.3242	30.4146	2.39	F
20	15120	3/20/91	12:59:14.5	69.2116	30.3971	2.36	F
21	15119	3/20/91	12:56:47.5	69.4586	30.5536	2.43	F
22	16662	3/29/91	12:48:24.2	69.3136	30.7052	2.22	F
23	16831	4/5/91	12:12:42.1	69.2123	30.5316	2.32	F
24	17743	4/10/91	12:25:08.5	69.3492	30.7017	2.26	F
26	20049	4/26/91	12:39:52.3	69.2289	30.7096	2.32	F
27	20449	4/30/91	12:34:46.5	69.3087	30.8716	3.44	F
29	24872	5/31/91	12:39:13.9	69.4000	30.7861	2.41	F
30	25681	6/5/91	12:30:59.7	69.3319	30.9285	2.28	F
31	25884	6/7/91	12:46:20.9	69.2714	30.8341	2.19	F
33	29048	7/5/91	12:20:10.9	69.2206	30.8688	2.35	F
34	29049	7/5/91	12:21:01.0	69.3351	30.8033	2.47	F
35	30841	7/17/91	12:18:36.7	69.3393	30.6918	2.38	F
36	31701	7/24/91	12:30:58.2	69.2847	30.7569	2.36	F
39	32971	7/31/91	13:30:04.5	69.1961	30.4679	2.38	F
44	35829	8/21/91	12:43:12.3	69.2217	30.8972	2.62	F
45	37564	8/30/91	12:22:24.6	69.3456	30.6235	2.37	F
46	37566	8/30/91	12:27:28.6	69.3353	30.7230	2.55	F
47	38374	9/6/91	14:11:15.0	69.2957	30.7056	2.42	F
48	39500	9/13/91	12:25:51.5	69.2719	30.6846	2.64	F
49	40446	9/18/91	12:30:33.7	69.3241	30.6111	2.76	F
50	41779	9/27/91	12:16:16.4	69.3483	30.9714	2.93	F
51	300147	10/2/91	13:45:28.2	69.2584	30.5853	2.49	F
52	300489	10/18/91	13:04:50.5	69.2593	30.6217	2.10	F

Table 34: Sorted events for area 11

Events #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
53	300783	10/25/91	13:58:56.4	69.3353	30.7689	2.75	F
55	301140	11/1/91	13:15:45.2	69.2130	30.6489	2.65	F
57	301995	11/22/91	14:02:42.1	69.2310	30.6730	2.52	F
58	302811	12/6/91	13:19:13.6	69.3755	30.5649	2.62	F
59	302991	12/18/91	13:22:12.6	69.3160	30.5983	2.02	F
61	303238	12/21/91	13:18:28.6	69.3877	30.6672	2.37	F
62	312845	12/27/91	13:30:08.8	69.2465	30.6618	2.63	F
63	312882	12/29/91	14:04:49.4	69.3549	30.7468	2.54	F
64	313708	1/17/92	13:23:56.6	69.3674	30.8010	2.49	F
65	313709	1/17/92	13:26:25.2	69.4448	30.7742	2.66	F
66	312843	12/27/91	13:29:10.2	69.3256	30.7628	2.61	F
67	315362	1/31/92	12:29:55.9	69.4339	30.6812	2.47	F
68	315447	2/6/92	12:21:00.9	69.3441	30.5701	2.14	F
69	319425	2/21/92	12:50:11.2	69.3412	30.6877	2.16	F
70	319426	2/21/92	12:51:02.8	69.3803	30.6828	2.46	F
71	320982	2/28/92	12:45:11.0	69.3646	30.6468	2.52	F
72	318098	2/28/92	12:48:20.2	69.3313	30.7165	2.22	F
73*	320988	2/28/92	12:48:57.1	69.2469	30.4055	2.30	F
74	319359	2/19/92	12:25:03.0	69.2571	30.5751	2.09	F
76	321681	3/6/92	12:09:46.5	69.3414	30.6213	2.27	F
77	320320	3/11/92	12:47:03.8	69.3476	30.7636	2.13	F
79	321023	3/18/92	12:57:45.3	69.2721	30.4741	2.34	F
81	323186	3/27/92	12:31:45.8	69.2781	30.5386	2.10	F
82	323332	4/1/92	11:02:33.4	69.3572	30.6140	2.13	F
84	326510	4/8/92	11:38:22.0	69.3858	30.6585	2.50	F
85	324432	4/10/92	11:29:51.2	69.3976	30.6444	2.24	F
86	326482	4/20/92	11:17:11.1	69.3135	30.5686	2.13	F
87	325462	4/22/92	11:03:30.7	69.3805	30.6203	2.15	F
88	326393	4/29/92	11:33:56.3	69.3718	30.5097	2.34	F
89	326396	4/29/92	11:37:50.4	69.2292	30.4617	2.03	F

Table 34: Sorted events for area 11

Events #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
90	328716	5/22/92	11:28:34.3	69.2737	30.6483	2.20	F
91	328721	5/22/92	11:30:12.4	69.2377	30.5003	2.19	F
92	329123	5/27/92	11:24:10.8	69.3734	30.6508	2.52	F
93	329664	6/3/92	11:42:25.6	69.3607	30.7070	2.35	F
94	330611	6/10/92	11:46:32.9	69.3236	30.5574	2.71	F
95	331070	6/19/92	11:31:26.8	69.3708	30.6049	2.39	F
96	331074	6/19/92	11:35:40.4	69.2871	30.5566	2.66	F
97	331516	6/24/92	11:33:29.5	69.4143	30.6969	2.74	F
98	331692	6/26/92	10:46:26.7	69.2831	30.7222	2.58	F
99	333069	7/3/92	11:32:54.2	69.3723	30.7083	2.52	F
101	332890	7/10/92	11:35:05.3	69.4209	30.6518	2.40	F
102	333624	7/17/92	11:32:03.4	69.3219	30.5455	2.11	F
103	335324	8/7/92	11:54:39.6	69.2980	30.5441	2.12	F
104	335847	8/14/92	12:03:57.4	69.4463	30.5083	2.41	F
105	336568	8/21/92	11:05:06.6	69.2852	30.1511	2.27	F
107	336574	8/21/92	11:14:26.6	69.3349	30.3955	2.49	F
109	340517	9/23/92	11:37:02.4	69.3829	30.7301	2.62	F
110	340518	9/23/92	11:38:19.9	69.4067	30.8400	2.32	F
112	340928	10/7/92	12:31:43.4	69.3250	30.6213	2.56	F
114	341887	10/21/92	12:30:52.7	69.2498	30.6720	2.50	F
115	342315	10/28/92	12:33:20.9	69.4319	30.5833	2.48	F
116	342312	10/28/92	12:34:05.3	69.2574	30.6018	2.42	F
117	342482	10/30/92	12:54:52.5	69.3858	30.7318	2.78	F
118	343878	11/20/92	13:24:30.8	69.3275	30.5390	2.32	F
119	343875	11/20/92	13:25:19.2	69.3294	30.6899	2.57	F
120	344527	11/27/92	12:22:05.1	69.2480	30.4971	2.27	F
121	344675	11/30/92	14:10:11.8	69.3945	30.6678	2.81	F
122*	344969	12/4/92	12:36:22.9	69.4438	30.7048	2.50	F
124	346355	12/25/92	12:29:41.3	69.4306	30.7936	2.69	F

a. Mixed event

Remarks:

- Groups A, C and E consist of mixed events that were reliably sorted. A couple of mixed events can also be found in group F.
- All events from group F except two were identified as coming from mine HK3 in the Helsinki bulletin.
- All events from group B and all events except two from group D were identified as coming from mine HN1 in the Helsinki bulletin.
- No less than 9 mines were located on SPOT photos; nevertheless, all events found in the Helsinki bulletin were located at mine HK3 whose closest SPOT mine location is SD8.

Mine and event locations:

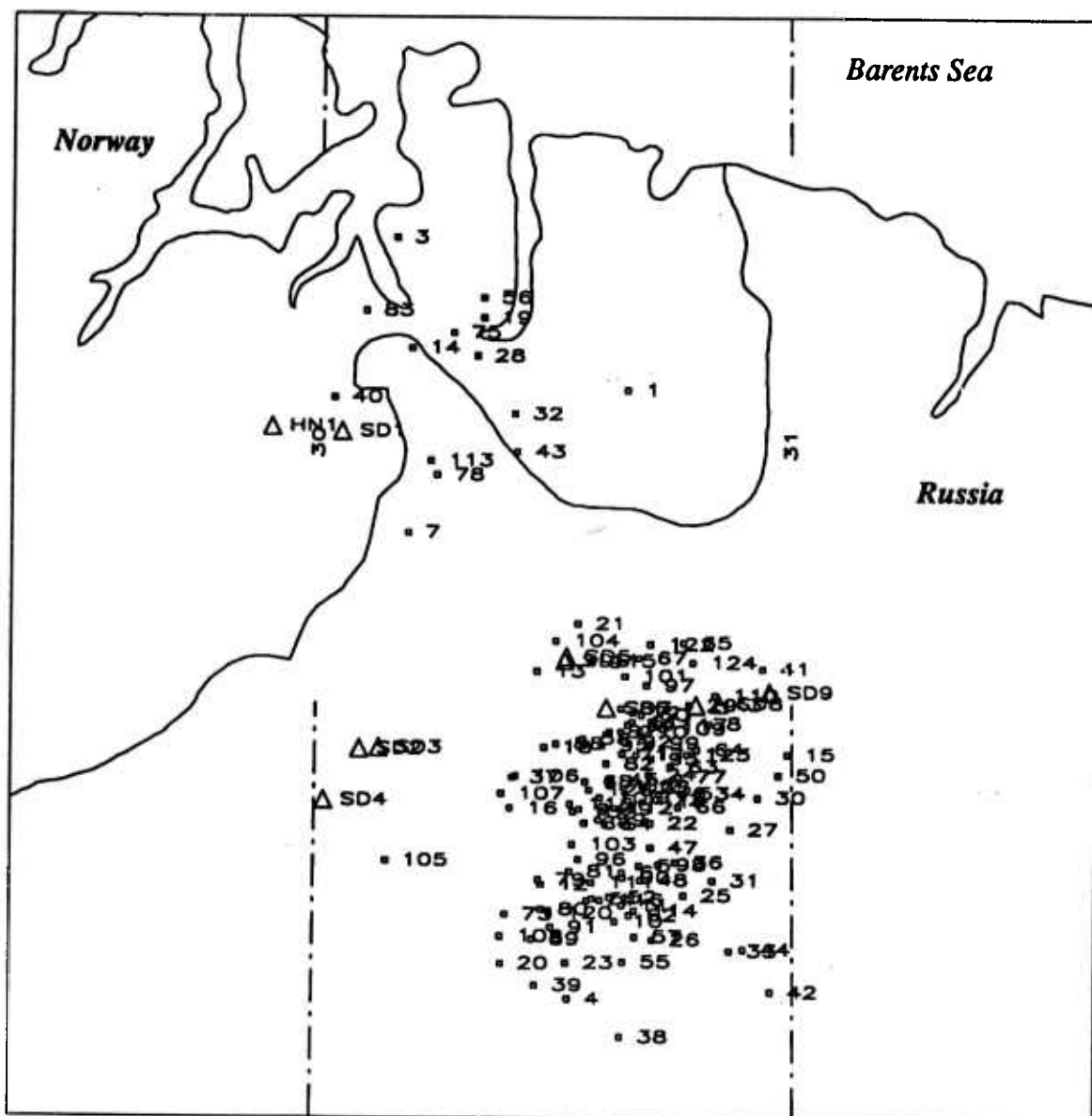


Figure 12: Mine and IMS event locations for area 11. The Norwegian mine locations have not been plotted on this map.

AREA 12

Latitude: 69 - 70°N

Longitude: 31 - 32°E

Local magnitude range: > 1.0

Reported mine locations: None

Number of events in IMS2: 254

Number of events within the magnitude range: 109

Number of processed events: 86

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 5s. before P, 47s. after P

Number of reference events: 4

Table 35: Reference events for area 12

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
16	26841	812772	914997	0.77	A
86	344808	1523100	2873931	0.80	B
11	19799	754329	700181	0.79	C
49	36690	913020	1144424	0.78	D

Number of events found in the Helsinki bulletin: 9

Table 36: Events found in the Helsinki bulletin for area 12

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL label	Group
66	321807	3/20/92	12:59:15.5	2.34	HK3	EXP	-
7	17748	4/10/91	12:28:15.0	2.03	HK3	EXP	A
16	26841	6/14/91	12:38:23.7	2.33	HK3	EXP	A
29	30843	7/17/91	12:21:11.3	2.35	HK3	EXP	A
44	35830	8/21/91	12:45:39.0	2.26	HK3	EXP	A
64	302452	11/29/91	14:13:19.3	2.77	HK3	EXP	A
5	16634	3/29/91	09:28:02.2	1.39	HK6	EXP	B
6	16633	3/29/91	09:27:15.2	1.22	HK6	EXP	B
15	23086	5/17/91	08:14:10.3	1.99	HK6	EXP	B

Events with the most reliable classification:

Table 37: Sorted events for area 12

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
7	17748	4/10/91	12:28:15.0	69.3783	31.0824	2.03	A
14 ^a	22910	5/16/91	20:30:09.6	69.5106	31.0653	2.29	A
16	26841	6/14/91	12:38:23.7	69.2905	31.0562	2.33	A
29	30843	7/17/91	12:21:11.3	69.4233	31.1004	2.35	A
44	35830	8/21/91	12:45:39.0	69.3163	31.0965	2.26	A
64 ^a	302452	11/29/91	14:13:19.3	69.4709	31.0478	2.77	A
85	344677	11/30/92	14:10:39.3	69.4223	31.6375	2.90	A
2	40000	11/30/90	10:10:13.1	69.3076	31.8669	1.09	B
5	16634	3/29/91	09:28:02.2	69.4729	31.3768	1.39	B
6	16633	3/29/91	09:27:15.2	69.7749	31.9132	1.22	B
9	19793	4/25/91	06:15:56.8	69.2905	31.8555	1.30	B
10	19796	4/25/91	06:21:39.0	69.2666	31.9961	1.57	B
15	23086	5/17/91	08:14:10.3	69.2531	31.8445	1.99	B
18	27150	6/21/91	14:27:12.9	69.6427	31.8648	1.31	B
65	321356	3/19/92	08:42:30.5	69.5464	31.7412	1.07	B
78	332666	7/8/92	11:57:59.5	69.6172	31.6889	1.41	B
82	338285	9/9/92	12:36:05.8	69.7327	31.7446	1.08	B
83	339216	9/18/92	12:06:54.2	69.5339	31.8312	1.51	B
84	340969	10/8/92	07:49:19.0	69.5507	31.9519	1.74	B
86	344808	12/3/92	08:33:20.4	69.4533	31.7553	1.61	B
11	19799	4/25/91	06:26:01.5	69.2463	31.9024	1.64	C
13	19491	4/26/91	14:20:38.7	69.2753	31.8816	1.96	C
79	333477	7/16/92	07:11:50.0	69.3113	31.8723	1.23	C
1	10049	11/29/90	12:40:43.8	69.1969	31.6000	1.04	D
3	15339	3/27/91	13:39:08.5	69.1324	31.2484	1.09	D
4	15979	3/28/91	13:52:43.2	69.0804	31.7221	1.13	D
8	18720	4/15/91	14:01:54.9	69.1556	31.9245	1.37	D
12	19850	4/25/91	12:56:47.5	69.5200	31.8727	1.15	D

Table 37: Sorted events for area 12

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
17	26847	6/14/91	14:55:31.5	69.5617	31.6061	1.14	D
19	28033	6/25/91	15:03:51.2	69.4503	31.5717	1.04	D
20	27843	6/27/91	09:38:33.0	69.5997	31.6162	1.05	D
21	28766	7/4/91	08:34:00.8	69.5468	31.4867	1.04	D
22	29999	7/12/91	09:29:19.2	69.4911	31.5600	1.04	D
23	30146	7/13/91	07:54:13.1	69.5824	31.5324	1.03	D
24	30390	7/15/91	07:19:14.0	69.5185	31.5692	1.08	D
25	30392	7/15/91	08:52:15.5	69.4853	31.5124	1.04	D
26	30403	7/15/91	13:35:27.1	69.5781	31.5681	1.06	D
27	30587	7/16/91	07:10:36.4	69.6370	31.5284	1.03	D
28	29932	7/16/91	08:31:10.8	69.6737	31.6381	1.02	D
30	30240	7/18/91	07:12:28.7	69.5382	31.5679	1.04	D
31	30716	7/18/91	14:01:52.6	69.6050	31.6334	1.03	D
32	30430	7/19/91	09:45:40.7	69.4884	31.5932	1.05	D
33	31250	7/22/91	08:06:02.1	69.5136	31.4650	1.16	D
34	30920	7/23/91	07:38:19.0	69.4959	31.5103	1.03	D
35	31406	7/23/91	09:51:38.9	69.5009	31.4754	1.14	D
36	31440	7/23/91	12:55:15.1	69.5038	31.4759	1.23	D
37	31452	7/23/91	14:08:43.1	69.5284	31.5540	1.11	D
38	32746	7/30/91	12:25:03.9	69.4798	31.5914	1.33	D
39	34070	8/6/91	08:31:28.3	69.4275	31.4897	1.03	D
40	35589	8/20/91	07:42:21.8	69.6318	31.6514	1.11	D
41	35593	8/20/91	09:13:42.5	69.4961	31.5626	1.07	D
42	35611	8/20/91	14:12:28.9	69.5337	31.6147	1.18	D
43	35817	8/21/91	09:42:51.9	69.5173	31.6408	1.35	D
45	35848	8/21/91	14:00:27.5	69.4224	31.7978	1.20	D
46	36101	8/23/91	08:02:20.1	69.5393	31.8088	1.08	D
47	36135	8/23/91	14:05:23.8	69.4236	31.9989	1.04	D
48	35624	8/23/91	14:06:24.6	69.5343	31.5125	1.06	D
49	36690	8/28/91	09:10:18.9	69.5126	31.5387	1.22	D

Table 37: Sorted events for area 12

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
50	36691	8/28/91	09:11:11.3	69.5159	31.7544	1.18	D
51	37146	9/3/91	09:23:31.8	69.5084	31.5168	1.29	D
52	37714	9/3/91	14:28:04.2	69.5568	31.4837	1.15	D
53	37313	9/4/91	10:49:22.3	69.4856	31.4766	1.42	D
54	37314	9/4/91	10:50:46.3	69.5499	31.4765	1.21	D
55	38152	9/5/91	09:13:13.9	69.5816	31.6023	1.17	D
56	39131	9/10/91	09:17:26.0	69.5367	31.4896	1.17	D
57	38360	9/10/91	14:07:45.2	69.5430	31.4693	1.16	D
58	38363	9/10/91	14:26:39.3	69.4948	31.3478	1.45	D
59	39470	9/11/91	09:03:30.3	69.4399	31.5353	1.08	D
60	39627	9/11/91	14:25:17.7	69.4983	31.5817	1.21	D
61	39835	9/12/91	14:29:58.9	69.5455	31.7970	1.08	D
62	39834	9/12/91	14:31:32.9	69.5717	31.5422	1.21	D
63	38846	9/13/91	08:17:39.7	69.4811	31.4874	1.00	D
67	331224	6/15/92	09:50:20.9	69.5009	31.4623	1.38	D
68	331313	6/15/92	12:52:30.7	69.4217	31.4533	1.37	D
69	331315	6/15/92	13:13:12.2	69.4667	31.4646	1.18	D
70	331316	6/15/92	14:01:30.5	69.4563	31.4718	1.18	D
71	330870	6/17/92	02:58:36.3	69.0669	31.3860	1.20	D
72	331174	6/20/92	15:12:14.7	69.4596	31.3729	1.13	D
73	331296	6/22/92	12:59:49.4	69.4738	31.2756	1.14	D
74	331297	6/22/92	13:25:45.6	69.4450	31.2720	1.24	D
75	331298	6/22/92	13:45:27.1	69.5056	31.2869	1.07	D
76	331511	6/24/92	11:45:27.8	69.4991	31.1410	1.09	D
77	332980	6/24/92	12:02:15.7	69.4522	31.2559	1.09	D
80	335165	8/5/92	12:17:24.1	69.4274	31.3832	1.01	D
81	337167	8/27/92	13:22:56.5	69.4202	31.4508	1.01	D

a. Mixed event

Remarks:

- The locations of events from group D spread over an area of 50 x 50 km. The closest mines to the center of the event cluster (Figure 13) are SD9 (area 11) and SD10 (area 13) which are about 25 km away. None of these events have been reported in the Helsinki bulletin.
- Events from groups A and B have well defined origins according to the identification found in the Helsinki bulletin. They come from mines HK3 (area 11) and HK6 (area 13), respectively.
- The IMS locations for events from group B are unusually scattered for events that originate from the same mine. The distance between event 6 and event 15 is about 58km.
- Events from group B are located too close to the array with respect to the mine location HK6.

Mine and event locations:

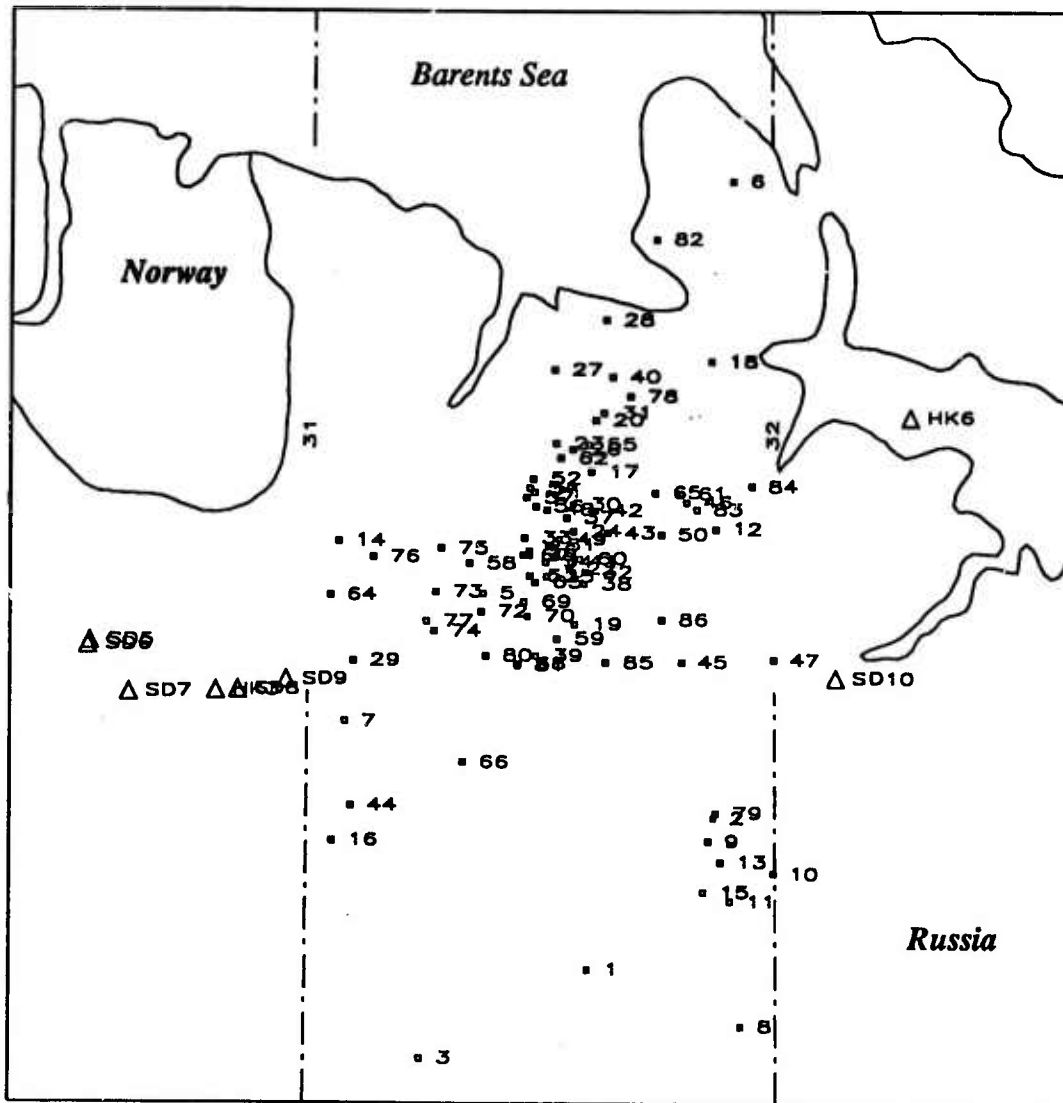


Figure 13: Mine and IMS event locations for area 12.

AREA 13

Latitude: 69 - 70°N

Longitude: 32 - 34°E

Local magnitude range: > 1.0

Number of events in IMS2: 256

Number of events within the magnitude range: 105

Number of processed events: 79

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 7s. before P, 59s. after P

Number of reference events: 12

Table 38: Reference events for area 13

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
22	28301	825093	941207	0.66	A
12	22301	775236	760713	0.77	B
45	302409	1008756	1468594	0.85	C
56	323098	1226703	1847106	0.80	D
40	40890	945982	1253278	0.77	E
19	27879	823560	927060	0.86	F
30	30887	852435	995216	0.83	G
77	344816	1523114	2874156	0.82	H
33	33277	872388	1072376	0.92	I
35	34983	882951	1123589	0.79	J
51	321732	1225484	1830480	0.83	K
46	302359	1009955	1512594	0.93	L

Reported mine locations:

Table 39: Mine locations for area 13

Label	Latitude °N	Longitude °E	Origin
SD23	69.012	33.641	SPOT
SD24	69.013	32.939	SPOT
SD22	69.034	33.506	SPOT
SD21	69.060	33.484	SPOT

Table 39: Mine locations for area 13

Label	Latitude °N	Longitude °E	Origin
SD20	69.093	33.482	SPOT
SD19	69.111	33.594	SPOT
HD7	69.2	33.3	old_HELS
SD15	69.223	33.168	SPOT
HK12	69.23	33.17	HELS
SD14	69.256	33.106	SPOT
SD12	69.276	32.811	SPOT
SD13	69.286	32.903	SPOT
SD11	69.299	32.721	SPOT
SD10	69.410	32.135	SPOT
HD4	69.6	32.3	old_HELS
HK6	69.6	32.3	HELS

Number of events found in the Helsinki bulletin: 14

Table 40: Events found in the Helsinki bulletin for area 13

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
6	17987	4/12/91	13:58:27.1	2.17	HK6	EXP	-
7	17990	4/12/91	14:03:52.8	2.26	HK6	EXP	-
8	17989	4/12/91	14:05:00.4	2.33	HK6	EXP	-
10	17991	4/12/91	14:02:52.7	2.20	HK6	EXP	-
14	23082	5/17/91	07:55:44.4	1.86	HK6	EXP	-
15	23087	5/17/91	08:16:53.3	2.02	HK6	EXP	-
25	28321	6/28/91	13:49:38.3	1.90	HK6	EXP	A
26	28322	6/28/91	13:49:53.7	2.23	HK6	EXP	A
4	15453	3/22/91	10:00:41.8	1.43	HD7	EXP	C
31	31060	7/19/91	14:05:21.8	2.21	HK6	EXP	D
47	303334	1/8/92	08:21:08.3	1.64	HK6	EXP	H
24	28310	6/28/91	13:46:45.1	1.92	HK6	EXP	J

Table 40: Events found in the Helsinki bulletin for area 13

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
23	28306	6/28/91	13:44:37.8	2.07	HK6	EXP	K
16	23953	5/24/91	09:59:52.7	1.48	HD7	EXP	L

Events with the most reliable classification:

Table 41: Sorted events for area 13

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
21 ^a	28297	6/28/91	13:42:32.5	69.5966	32.0560	1.74	A
22 ^a	28301	6/28/91	13:42:48.1	69.3755	32.2155	2.32	A
25 ^a	28321	6/28/91	13:49:38.3	69.5859	32.0043	1.90	A
26 ^a	28322	6/28/91	13:49:53.7	69.4441	32.2368	2.23	A
12	22301	5/8/91	11:57:36.0	69.2026	32.1748	2.37	B
72	337257	8/28/92	11:33:33.6	69.3794	33.9395	3.08	B
3	14382	3/13/91	12:52:12.8	69.0931	33.0705	1.93	C
4	15453	3/22/91	10:00:41.8	69.0508	32.8404	1.43	C
17	25867	6/7/91	10:11:08.0	69.0873	32.9138	1.33	C
44	301164	11/5/91	11:08:47.1	69.1648	32.9714	1.35	C
45	302409	11/29/91	11:05:55.0	69.0370	32.8738	1.41	C
48	315682	2/4/92	10:15:35.6	69.0222	32.9649	1.30	C
5	16597	4/2/91	09:00:58.0	69.3293	33.3165	2.03	D
31	31060	7/19/91	14:05:21.8	69.0745	32.1412	2.21	D
39	35812	8/21/91	08:19:11.0	69.2732	33.3220	1.31	D
53	323095	3/25/92	07:18:50.3	69.2839	33.0450	1.80	D
54	323097	3/25/92	07:28:26.4	69.4098	33.2965	1.74	D
56	323098	3/25/92	07:34:46.3	69.4017	33.5435	1.83	D
9	18726	4/15/91	16:18:23.5	69.3123	33.9732	1.04	E
40	40890	9/19/91	08:49:58.6	69.3542	33.9707	1.09	E
70	337161	8/27/92	12:40:33.1	69.5050	33.6333	1.16	E
78	344904	12/4/92	07:20:26.3	69.3709	33.7060	1.24	E
11	18747	4/18/91	06:27:39.3	69.1493	32.4482	1.06	F

Table 41: Sorted events for area 13

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
19	27879	6/27/91	18:09:24.7	69.1440	32.7091	1.18	F
52	322852	3/23/92	14:23:28.8	69.0471	32.7548	1.06	F
60	326532	4/8/92	15:03:15.3	69.0147	32.7758	1.12	F
64	330879	6/17/92	08:13:16.9	69.1197	32.0339	1.02	F
68	334926	7/15/92	12:17:45.7	69.0458	32.7477	1.01	F
28	29457	7/9/91	10:38:27.6	69.0802	32.3643	1.14	G
29	29366	7/10/91	11:05:56.5	69.0921	32.2713	1.22	G
30	30887	7/19/91	09:26:11.0	69.0319	32.3860	1.48	G
32	31445	7/23/91	13:10:01.3	69.0000	32.3120	1.39	G
75	344441	11/24/92	11:18:27.0	69.3939	32.3731	1.42	G
41	40894	9/19/91	09:49:56.8	69.3819	32.4987	1.76	H
47	303334	1/8/92	08:21:08.3	69.5362	32.1073	1.64	H
50	324195	3/19/92	08:45:40.0	69.6437	32.1852	1.15	H
74	340968	10/8/92	07:15:23.9	69.5449	32.7072	1.79	H
77	344816	12/3/92	10:18:56.0	69.4455	33.0590	1.17	H
33	33277	8/2/91	08:48:09.3	69.3727	32.1765	1.45	I
36	34984	8/9/91	09:17:07.1	69.3743	32.1668	1.39	I
18	27149	6/21/91	14:22:57.8	69.7218	32.0080	1.38	J
20	28292	6/28/91	13:42:19.1	69.0698	32.2440	1.95	J
24	28310	6/28/91	13:46:45.1	69.7319	32.0719	1.92	J
34	33279	8/2/91	08:51:25.7	69.6326	32.2256	1.49	J
35	34983	8/9/91	09:15:03.9	69.4275	32.0796	1.35	J
65	331155	6/20/92	09:27:57.3	69.4458	32.0188	1.47	J
66	331676	6/26/92	09:10:49.3	69.2643	32.0267	1.02	J
67	333321	7/14/92	12:57:22.5	69.3960	33.4689	1.15	J
69	333471	7/16/92	05:01:33.5	69.6097	32.7464	1.16	J
23	28306	6/28/91	13:44:37.8	69.2486	32.1652	2.07	K
37	34987	8/9/91	09:26:38.8	69.3767	32.1610	1.90	K
51	321732	3/20/92	10:21:16.3	69.6550	32.0104	1.34	K
16	23953	5/24/91	09:59:52.7	69.0239	32.4184	1.48	L

Table 41: Sorted events for area 13

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
43	300746	10/25/91	11:09:39.0	69.1910	33.1098	1.73	L
46	302359	12/10/91	11:12:07.5	69.0044	32.2850	1.67	L
49	322251	3/10/92	10:07:48.0	69.2929	33.0759	1.61	L

a. Mixed events

Remarks:

- Events from group C and group L are very similar; according to the identification made in the Helsinki bulletin, they probably come from the same mine.
- The other events that were identified as being from mine HK6 in the Helsinki bulletin do not show the same degree of similarity.

Mine and event locations:

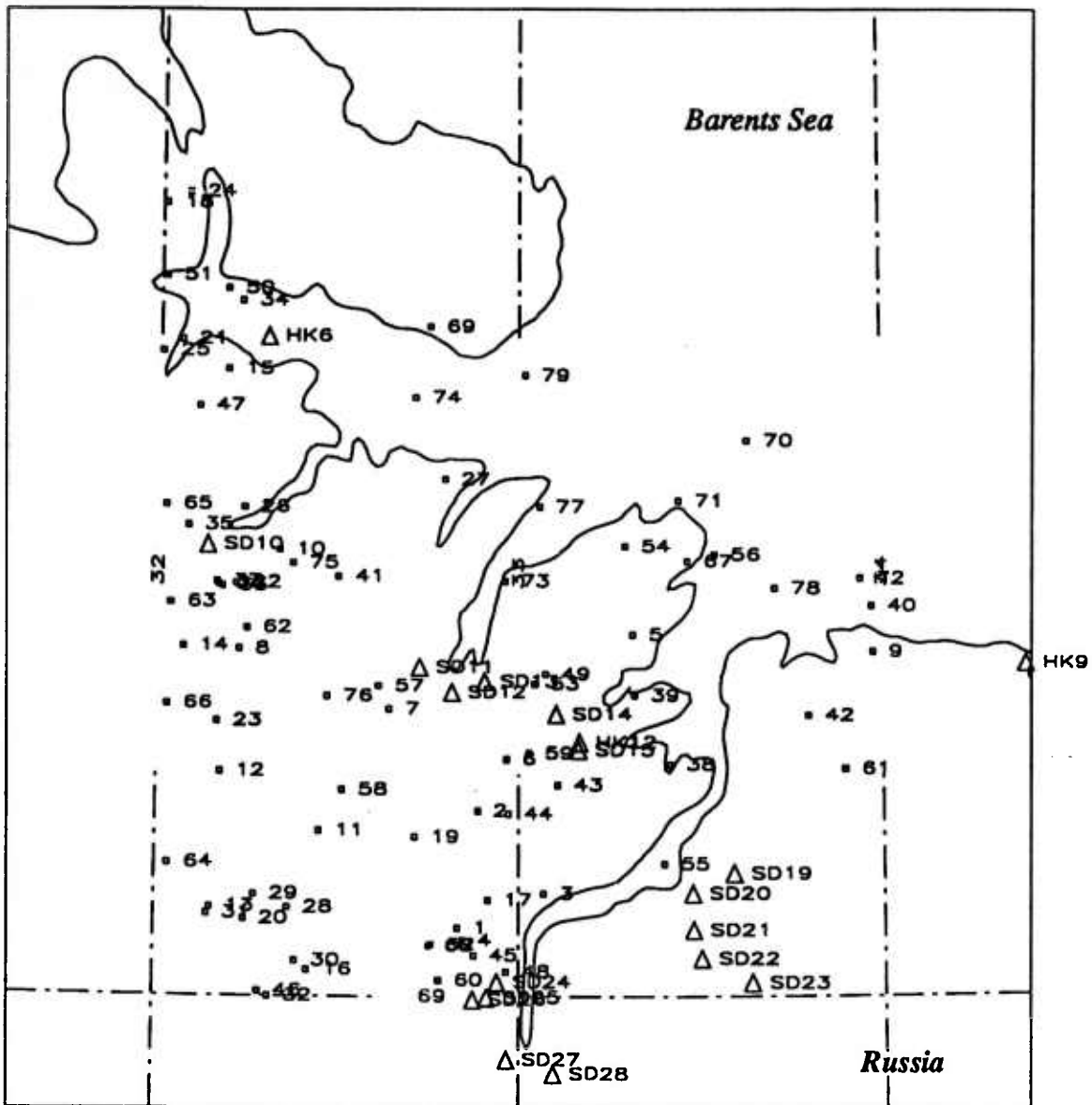


Figure 14: Mine and IMS event locations for area 13.

AREA 14

Latitude: 68 - 70°N

Longitude: 34 - 38°E

Local magnitude range: -

Number of events in IMS2: 79

Number of events within the magnitude range: 79

Number of processed events: 51

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 9s. before P, 79s. after P

Number of reference events: None

Reported mine locations:

Table 42: Mine locations for area 14

Label	Latitude °N	Longitude °E	Origin
SD46	68.006	34.697	SPOT
JOG61	68.01	34.71	JOG
SD45	68.019	34.349	SPOT
JOG60	68.02	34.37	JOG
JOG62	68.82	35.37	JOG
SD18	68.932	34.938	SPOT
SD17	69.064	35.008	SPOT
SD16	69.070	35.008	SPOT
HD12	69.2	34.7	old_HELS
HK10	69.2	34.7	HELS
HD11	69.3	34.4	old_HELS
HK9	69.3	34.4	HELS

Number of events found in the Helsinki bulletin: 3

Table 43: Events found in the Helsinki bulletin for area 14

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
1	2593	11/16/90	10:10:36.7	2.74	HK5	EXP	-
5	16321	3/23/91	14:14:13.1	2.85	HK9	EXP	-
16	18751	4/18/91	07:20:49.3	2.43	HD12	EXP	-

Remarks:

- A third of these events consists of mixed events, another third has very low signal-to-noise ratio and cannot be reliably classified into groups, and the remaining events are not similar. The event locations in Figure 15 seem to confirm that these events have diverse origins.

Mine and event locations:

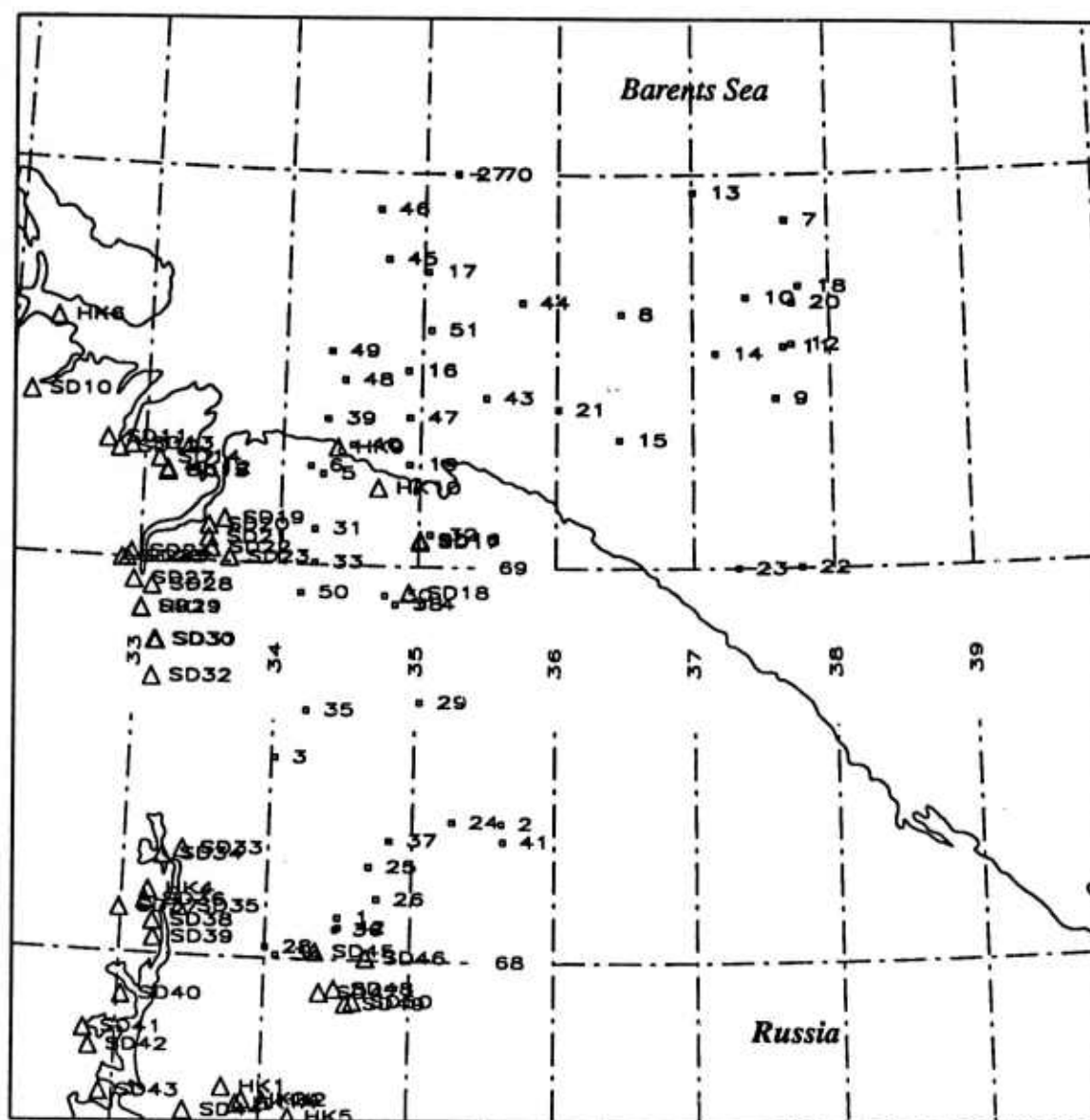


Figure 15: Mine and IMS event locations for area 14.

AREA 15

Latitude: 66 - 68°N

Longitude: 34 - 38°E

Local magnitude range: > 1.0

Number of events in IMS2: 343

Number of events within the magnitude range: 51

Number of processed events: 39

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 9s. before P, 79s. after P

Number of reference events: 2

Table 44: Reference events for area 15

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
37	344686	1522701	2869743	0.76	A
38	345204	1528053	2884926	0.79	B

Reported mine locations:

Table 45: Mine locations for area 15

Label	Latitude °N	Longitude °E	Origin
HD10	67.6	34.2	old_HELS
HK5	67.6	34.2	HELS
HK2	67.64	34.02	HELS
JOG56	67.88	34.55	JOG
SD49	67.889	34.566	SPOT
SD50	67.895	34.615	SPOT
JOG57	67.90	34.63	JOG
SD47	67.916	34.385	SPOT
SD48	67.926	34.486	SPOT
JOG55	67.93	34.48	JOG

Number of events found in the Helsinki bulletin: 30

Table 46: Events found in the Helsinki bulletin for area 15

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
2	10159	12/1/90	11:52:54.8	2.57	HD10		EXP	-
3	10225	12/2/90	11:12:54.3	2.21	HD6		EXP	-
4	314429	12/21/90	13:51:16.0	2.15	HD10		EXP	-
11	19072	4/24/91	16:02:00.7	2.15	HD10		EXP	-
12	22721	5/14/91	11:45:36.1	2.00	HK5		EXP	-
15	28121	6/28/91	07:57:03.0	2.33	HK5		EXP	-
28	328714	5/22/92	11:51:35.9	2.40	HK5		EXP	-
1	3359	11/23/90	12:42:04.1	2.78	HD10		EXP	A
8	10152	2/1/91	12:24:16.1	2.48	HD8		EXP	A
9	13449	3/7/91	09:47:08.5	2.50	HD10		EXP	A
13	23109	5/17/91	10:43:34.1	2.80	67.64	34.49	-	A
16	27800	6/30/91	06:33:01.5	2.27	HK1		EXP	A
17	35033	8/9/91	12:28:35.2	2.11	HK2		EXP	A
18	34551	8/15/91	08:35:40.1	2.32	HK2		EXP	A
21	301243	11/3/91	09:07:43.8	2.57	HK5		EXP	A
22	301456	11/9/91	06:05:12.9	2.37	HK5		EXP	A
23	302841	12/13/91	08:55:03.1	2.60	HK5		EXP	A
25	325704	4/3/92	06:27:20.5	2.59	HK2		EXP	A
27	327886	5/15/92	07:35:41.9	2.47	HK5		EXP	A
33	333115	7/12/92	03:24:45.1	2.26	HK2		EXP	A
34	334229	7/24/92	09:54:06.8	2.22	HK5		EXP	A
36	336589	8/21/92	13:56:00.7	2.01	67.86	34.43	-	A
5	7618	1/15/91	10:13:31.8	2.10	HD10		EXP	B
6	9125	1/26/91	18:30:32.8	2.56	HD10		EXP	B
10	14261	3/19/91	12:34:29.7	2.40	HD8		EXP	B
14	23171	5/17/91	13:13:41.0	2.28	HD8		EXP	B
19	36124	8/23/91	13:06:49.0	2.18	HK1		EXP	B
26	325102	4/17/92	10:04:35.0	2.41	HK5		EXP	B

Table 46: Events found in the Helsinki bulletin for area 15

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
32	332336	7/3/92	12:14:20.4	2.13	HK5	EXP	B
35	334791	7/31/92	09:57:37.9	2.24	HK2	EXP	B

Events with the most reliable classification:

Table 47: Sorted events for area 15

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
1	3359	11/23/90	12:42:04.1	67.6561	34.7603	2.78	A
8	10152	2/1/91	12:24:16.1	67.3998	34.0420	2.48	A
9	13449	3/7/91	09:47:08.5	67.5896	34.2262	2.50	A
13	23109	5/17/91	10:43:34.1	67.6962	34.1831	2.80	A
16	27800	6/30/91	06:33:01.5	67.7080	34.0495	2.27	A
17	35033	8/9/91	12:28:35.2	67.7827	34.2835	2.11	A
18	34551	8/15/91	08:35:40.1	67.6170	34.1312	2.32	A
21	301243	11/3/91	09:07:43.8	67.7948	34.1165	2.57	A
22	301456	11/9/91	06:05:12.9	67.8972	34.2504	2.37	A
23	302841	12/13/91	08:55:03.1	67.6982	34.0745	2.60	A
24	322297	3/17/92	20:26:00.6	67.5671	34.0543	2.03	A
25	325704	4/3/92	06:27:20.5	67.7798	34.2026	2.59	A
27	327886	5/15/92	07:35:41.9	67.3649	34.7914	2.47	A
33	333115	7/12/92	03:24:45.1	67.7218	34.2358	2.26	A
34	334229	7/24/92	09:54:06.8	67.4261	34.0312	2.22	A
36	336589	8/21/92	13:56:00.7	67.6978	34.3065	2.01	A
37	344686	11/30/92	16:24:54.3	67.8820	34.1513	2.28	A
39	346346	12/25/92	08:03:29.1	67.6193	34.3156	2.03	A
5	7618	1/15/91	10:13:31.8	67.6810	34.1280	2.10	B
6	9125	1/26/91	18:30:32.8	67.6067	34.0077	2.56	B
10	14261	3/19/91	12:34:29.7	67.5051	34.0241	2.40	B
14	23171	5/17/91	13:13:41.0	67.6927	34.0644	2.28	B
19	36124	8/23/91	13:06:49.0	67.5571	34.0863	2.18	B

Table 47: Sorted events for area 15

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
26	325102	4/17/92	10:04:35.0	67.5454	34.2509	2.41	B
32	332336	7/3/92	12:14:20.4	67.3481	34.2323	2.13	B
35	334791	7/31/92	09:57:37.9	67.8633	34.0808	2.24	B
38	345204	12/11/92	11:51:00.7	67.6726	34.0221	2.15	B

Remarks:

- The comparison between the classification of the events into groups and the identification made in the Helsinki bulletin shows some discrepancy. As an example, it is difficult to see more difference between events 18 and 22 , which are supposed to be from two different mines, than between events 18 and 25, which are supposed to be from the same mine. However, the data analyzed in this study were recorded at a much larger distance than the data used by the Finnish analysts to identify the events.

- The same remark can be made concerning the classification of the events into two groups. The differences between these two groups are not obvious.

Mine and event locations:

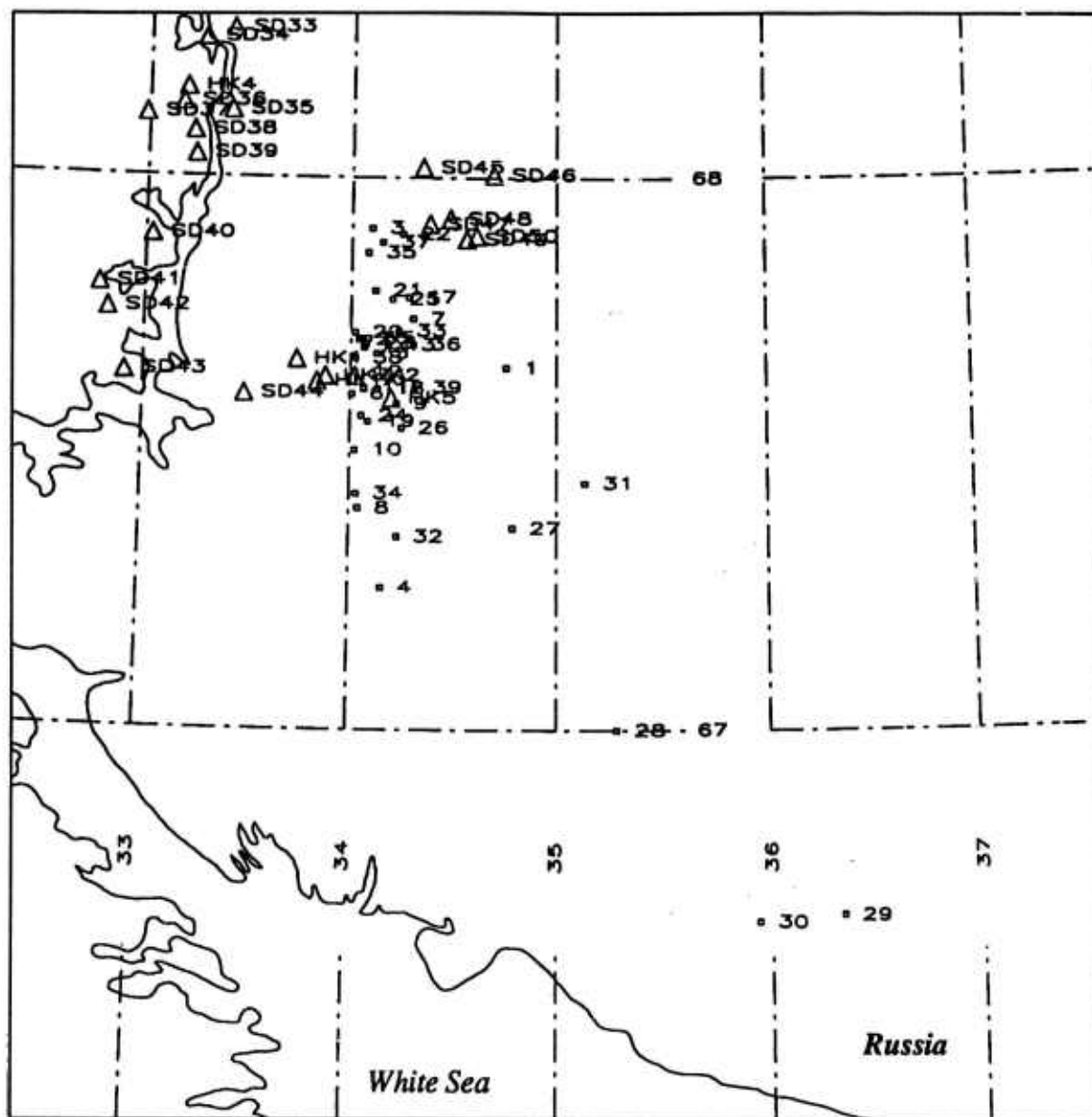


Figure 16: Mine and IMS event locations for area 15.

AREA 16

Latitude: 67 - 68°N

Longitude: 33 - 34°E

Local magnitude range: > 2.0

Number of events in IMS2: 1621

Number of events within the magnitude range: 50

Number of processed events: 44

Frequency range used to process the data: 1 - 16 Hz

Processed signal length: 10s. before P, 86s. after P

Number of reference events: 3

Table 48: Reference events for area 16

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
13	11204	591092	1370650	0.83	A
15	8886	596635	1372459	0.80	B
7	6043	575609	1367095	0.79	C

Reported mine locations:

Table 49: Mine locations for area 16

Label	Latitude °N	Longitude °E	Origin
HD9	67.6	34.0	old_HELS
SD44	67.607	33.486	SPOT
HK1A	67.63	33.84	HELS
HK2A	67.64	33.88	HELS
JOG54	67.67	33.63	JOG
HK1	67.67	33.74	HELS
HD8	67.7	33.7	old_HELS
SD40	67.893	33.029	SPOT

Number of events found in the Helsinki bulletin: 36

Table 50: Events found in the Helsinki bulletin for area 16

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
10	319825	1/11/91	12:32:32.8	2.17	HK5		EXP	-
11	319826	1/11/91	12:32:59.0	2.40	HK5		EXP	-
16	9360	1/29/91	10:02:18.7	2.40	HD8		EXP	-
17	10143	2/1/91	11:43:14.2	2.29	HK5		EXP	-
20	13994	3/12/91	10:36:53.8	2.09	HD9		EXP	-
33	33457	8/2/91	13:31:20.1	2.29	HK1		EXP	-
36	35032	8/9/91	12:29:13.8	2.09	HK2		EXP	-
39	38108	9/5/91	05:09:28.3	2.60	HK2		EXP	-
41	40459	9/18/91	15:52:35.7	2.22	HK2		EXP	-
2	6791	12/29/90	11:01:55.6	2.28	67.63	34.6	-	A
13	11204	1/18/91	12:29:48.1	2.55	HD9		EXP	A
35	34104	8/6/91	12:31:49.7	2.48	HK5		EXP	A
1	7020	12/28/90	10:19:06.2	2.43	HD9		EXP	B
3	6511	12/30/90	05:02:17.1	2.65	HD8		EXP	B
4	5459	12/31/90	07:19:49.0	2.53	HD8		EXP	B
5	6012	1/5/91	10:23:30.2	2.16	HD9		EXP	B
15	8886	1/25/91	11:03:22.3	2.54	HK5		EXP	B
18	10256	2/3/91	04:57:08.1	2.83	HD8		EXP	B
19	13654	3/8/91	04:42:52.3	2.30	HD9		EXP	B
21	15559	3/22/91	12:47:51.5	2.47	HD9		EXP	B
24	18002	4/13/91	17:59:26.2	2.26	HD8		EXP	B
37	36102	8/23/91	08:24:15.5	2.56	HK5		EXP	B
38	37655	9/1/91	06:17:17.1	2.38	HK2		EXP	B
40	39557	9/11/91	12:34:59.1	2.21	HK2		EXP	B
42	40605	9/20/91	07:41:01.5	2.31	HK5		EXP	B
43	41665	9/25/91	18:09:16.2	2.26	HK1		EXP	B
6	6020	1/5/91	12:42:35.0	2.35	HD9		EXP	C
7	6043	1/5/91	21:29:32.0	2.23	HD8		EXP	C

Table 50: Events found in the Helsinki bulletin for area 16

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
8	6045	1/5/91	21:34:47.6	2.31	HD8	EXP	C
9	11721	1/11/91	09:33:56.5	2.66	HK5	EXP	C
12	11283	1/13/91	04:32:34.3	2.55	HD8	EXP	C
14	320333	1/19/91	09:18:51.0	2.28	HD9	EXP	C
23	15465	3/22/91	11:17:06.7	2.64	HD9	EXP	C
29	27666	6/18/91	10:06:52.9	2.06	HK2	EXP	C
30	30081	7/7/91	05:33:38.1	2.20	HK1	EXP	C
31	32973	7/30/91	15:59:46.3	2.54	HK1	EXP	C
32	33416	8/2/91	09:59:03.6	2.41	HK5	EXP	C
44	41753	9/27/91	08:35:56.7	2.27	HK5	EXP	C

Events with the most reliable classification:

Table 51: Sorted events for area 16

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
2	6791	12/29/90	11:01:55.6	67.4071	33.5922	2.28	A
13	11204	1/18/91	12:29:48.1	67.5248	33.4136	2.55	A
35	34104	8/6/91	12:31:49.7	67.5367	33.5134	2.48	A
1	7020	12/28/90	10:19:06.2	67.6974	33.8855	2.43	B
3	6511	12/30/90	05:02:17.1	67.6269	33.6993	2.65	B
4	5459	12/31/90	07:19:49.0	67.6350	33.9390	2.53	B
5	6012	1/5/91	10:23:30.2	67.6378	33.9802	2.16	B
15	8886	1/25/91	11:03:22.3	67.4794	33.9207	2.54	B
18	10256	2/3/91	04:57:08.1	67.7365	33.7700	2.83	B
19	13654	3/8/91	04:42:52.3	67.6731	33.8227	2.30	B
21	15559	3/22/91	12:47:51.5	67.5938	33.6511	2.47	B
24	18002	4/13/91	17:59:26.2	67.6494	33.8861	2.26	B
28	27462	6/16/91	05:39:52.0	67.6820	33.7293	2.53	B
37	36102	8/23/91	08:24:15.5	67.5989	33.7468	2.56	B
38	37655	9/1/91	06:17:17.1	67.5575	33.4753	2.38	B

Table 51: Sorted events for area 16

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
40	39557	9/11/91	12:34:59.1	67.4037	33.0372	2.21	B
42	40605	9/20/91	07:41:01.5	67.6871	33.8866	2.31	B
43	41665	9/25/91	18:09:16.2	67.5490	33.6078	2.26	B
6	6020	1/5/91	12:42:35.0	67.5673	33.3544	2.35	C
7	6043	1/5/91	21:29:32.0	67.7078	33.9329	2.23	C
8	6045	1/5/91	21:34:47.6	67.5538	33.5130	2.31	C
9	11721	1/11/91	09:33:56.5	67.5848	33.5061	2.66	C
12	11283	1/13/91	04:32:34.3	67.6259	33.8946	2.55	C
14	320333	1/19/91	09:18:51.0	67.6810	33.8771	2.28	C
23	15465	3/22/91	11:17:06.7	67.5467	33.4373	2.64	C
29	27666	6/18/91	10:06:52.9	67.5330	33.6068	2.06	C
30	30081	7/7/91	05:33:38.1	67.7184	33.4697	2.20	C
31	32973	7/30/91	15:59:46.3	67.6244	33.4745	2.54	C
32	33416	8/2/91	09:59:03.6	67.6483	33.9469	2.41	C
44	41753	9/27/91	08:35:56.7	67.5515	33.9060	2.27	C

Remarks:

- The event identification found in the Helsinki bulletin does not match the event association: within a group, events can be identified as coming from either HD9 or HK1. However, these two mines are only 13.5 km apart and differences in the signal seen at closer distances may not be seen at ARCESS.
- Events from groups B and C show some similarities.

Mine and event locations:

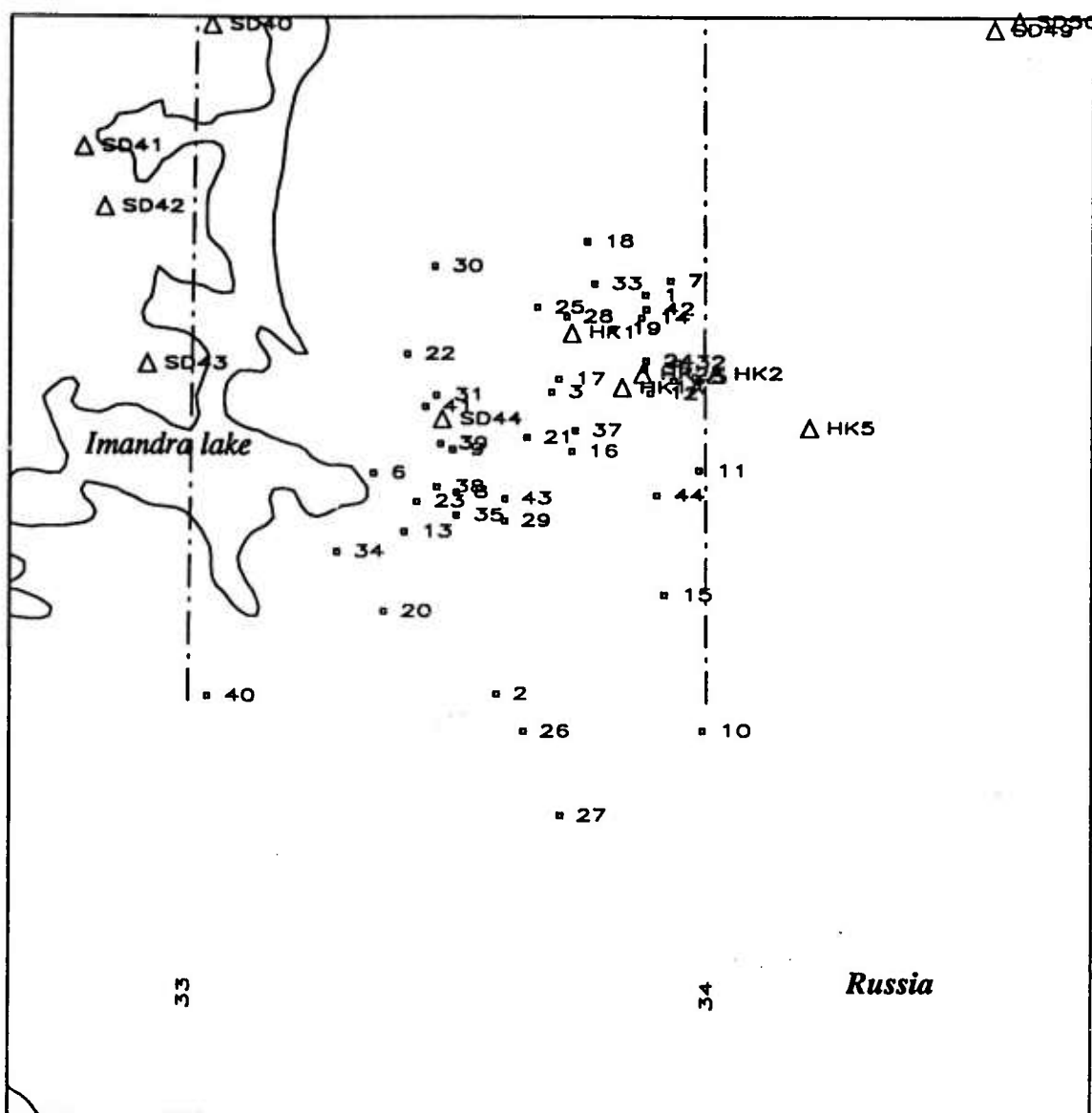


Figure 17: Mine and IMS event location for area 16.

AREA 17

Latitude: 67 - 68°N

Longitude: 32 - 33°E

Local magnitude range: > 1.5

Number of events in IMS2: 241

Number of events within the magnitude range: 93

Number of processed events: 78

Frequency range used to process the data: 2.5- 16 Hz

Processed signal length: 10s. before P, 86s. after P

Number of reference events: 8

Table 52: Reference events for area 17

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
52	320658	1215187	1807449	0.76	A
48	319424	1206199	1768359	0.80	B
11	18753	741183	613027	0.83	C
15	21835	773567	741447	0.76	D
68	337114	1412999	2611710	0.80	E
56	326612	1237743	2005290	0.79	F
30	35869	897029	1139336	0.80	G
54	325214	1234397	1964454	0.79	H

Reported mine locations: for area 17

Table 53: Mine locations for area 17

Label	Latitude °N	Longitude °E	Origin
JOG68	67.35	32.53	JOG
JOG70	67.45	32.66	JOG
SD43	67.645	32.912	SPOT
SD42	67.759	32.824	SPOT
SD41	67.803	32.781	SPOT

Number of events found in the Helsinki bulletin: 32

Table 54: Events found in the Helsinki bulletin for area 17

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
3	3311	11/23/90	11:58:10.2	1.89	HD9	EXP	-
6	316769	1/10/91	12:22:24.1	2.36	HD6	EXP	-
13	19269	4/19/91	12:28:24.5	2.09	HD9	EXP	-
20	25756	6/6/91	15:29:57.7	1.73	HK5	EXP	-
22	26046	6/10/91	07:06:26.9	1.76	HK5	EXP	-
31	37754	9/6/91	12:53:34.4	1.90	HK2	EXP	-
57	326825	5/1/92	02:14:15.3	1.95	HK1	EXP	-
69	337223	8/28/92	06:34:45.4	1.80	HK1	EXP	-
5	3010	11/6/90	12:15:57.0	2.16	HD6	EXP	A
10	17944	4/13/91	11:30:58.4	1.98	HD6	EXP	A
35	41623	9/25/91	11:15:59.8	2.23	HK1	EXP	A
43	303200	12/20/91	12:07:12.3	2.29	HK4	EXP	A
44	303210	12/20/91	14:15:10.1	1.91	HK4	EXP	A
52	320658	3/14/92	12:01:53.2	1.84	HK4	EXP	A
65	332954	7/11/92	10:01:34.3	1.93	HK4	EXP	A
51	320312	3/11/92	11:57:46.1	1.73	HK2	EXP	B
7	16624	3/29/91	08:47:44.9	1.84	HD6	EXP	C
14	21837	5/7/91	14:18:30.8	2.05	HD9	EXP	D
15	21835	5/7/91	14:18:37.3	2.24	HD9	EXP	D
24	28106	7/2/91	10:01:37.2	2.11	HK2	EXP	D
36	41762	9/27/91	10:20:56.6	2.40	HK1	EXP	D
60	330835	6/16/92	14:05:42.6	2.21	HK5	EXP	D
61	330864	6/16/92	23:39:01.9	2.12	HK2	EXP	D
26	31418	7/23/91	10:32:27.5	1.86	HK2	EXP	F
56	326612	4/30/92	10:49:16.1	2.18	HK2	EXP	F
59	330150	6/10/92	14:33:15.4	1.73	HK5	EXP	F
1	3010	11/6/90	12:15:57.0	2.16	HD6	EXP	G
29	34541	8/8/91	11:15:12.2	1.84	HK4	EXP	G

Table 54: Events found in the Helsinki bulletin for area 17

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
30	35869	8/22/91	12:29:17.3	1.97	HK4	EXP	G
33	40914	9/19/91	12:38:39.2	1.88	HK4	EXP	G
38	300831	10/26/91	12:36:34.8	1.93	HK4	EXP	G
63	331684	6/26/92	10:20:18.4	1.85	HK4	EXP	G

Events with the most reliable classification:

Table 55: Sorted events for area 17

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
5	4107	12/15/90	10:55:34.5	67.8624	32.0124	1.69	A
10	17944	4/13/91	11:30:58.4	67.8688	32.3473	1.98	A
35	41623	9/25/91	11:15:59.8	67.9718	32.6507	2.23	A
43	303200	12/20/91	12:07:12.3	67.9065	32.5784	2.29	A
44	303210	12/20/91	14:15:10.1	67.9008	32.2276	1.91	A
45	303230	12/21/91	11:06:38.5	67.9942	32.6983	1.84	A
47	320706	2/27/92	11:26:09.5	67.8007	32.0201	1.81	A
52	320658	3/14/92	12:01:53.2	67.9815	32.2047	1.84	A
65	332954	7/11/92	10:01:34.3	67.9990	32.6187	1.93	A
18	24795	5/31/91	09:49:47.9	67.2680	32.1333	1.53	B
40	301668	11/15/91	08:29:57.3	67.6114	32.3046	1.52	B
48	319424	3/4/92	07:32:29.8	67.5696	32.8186	1.65	B
51	320312	3/11/92	11:57:46.1	67.5802	32.4675	1.73	B
58	326989	5/5/92	10:01:09.6	67.7263	32.9926	1.63	B
7	16624	3/29/91	08:47:44.9	67.7209	32.9178	1.84	C
11	18753	4/18/91	07:53:18.9	67.8925	32.9445	1.71	C
50	322248	3/10/92	09:55:01.3	67.9097	32.5665	1.92	C
75	342798	11/3/92	15:34:15.2	67.9368	32.4854	1.76	C
14	21837	5/7/91	14:18:30.8	67.9474	32.1264	2.05	D
15	21835	5/7/91	14:18:37.3	67.7375	32.0791	2.24	D
16	21836	5/7/91	14:18:49.4	67.8979	32.1840	2.09	D

Table 55: Sorted events for area 17

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
21	26151	6/9/91	05:16:36.7	67.7746	32.3086	1.87	D
24	28106	7/2/91	10:01:37.2	67.4083	32.9921	2.11	D
36	41762	9/27/91	10:20:56.6	67.5351	32.9845	2.40	D
55	325397	4/21/92	14:21:28.8	67.9404	32.0587	1.64	D
60	330835	6/16/92	14:05:42.6	67.7342	32.3620	2.21	D
61	330864	6/16/92	23:39:01.9	67.5134	32.9791	2.12	D
72	341470	10/16/92	10:03:08.7	67.3597	32.8058	2.27	D
17	23027	5/17/91	04:42:11.1	67.2549	32.9809	1.90	E
66	334942	7/15/92	16:01:03.0	67.3753	32.9442	1.72	E
68	337114	8/27/92	03:28:18.6	67.3599	32.9363	2.00	E
73	342310	10/28/92	12:42:42.4	67.9584	32.1210	2.29	E
26	31418	7/23/91	10:32:27.5	67.7920	32.8920	1.86	F
56	376612	4/30/92	10:49:16.1	67.9215	32.1664	2.18	F
59	330150	6/10/92	14:33:15.4	67.9024	32.1384	1.73	F
71	341323	10/14/92	12:03:34.1	67.9116	32.2883	2.07	F
77	344535	11/27/92	13:20:10.1	67.6247	32.2969	2.13	F
1	3010	11/6/90	12:15:57.0	67.9856	32.6874	2.16	G
25	28940	7/4/91	10:56:06.8	67.8769	32.7720	1.74	G
27	33191	8/1/91	11:33:04.3	67.9317	32.3036	1.54	G
28	33190	8/1/91	11:33:16.6	67.9988	32.6035	1.67	G
29	34541	8/8/91	11:15:12.2	67.9797	32.8556	1.84	G
30	35869	8/22/91	12:29:17.3	67.9199	32.2669	1.97	G
33	40914	9/19/91	12:38:39.2	67.9772	32.9300	1.88	G
38	300831	10/26/91	12:36:34.8	67.8467	32.3237	1.93	G
41	301918	11/21/91	10:43:30.4	67.9864	32.8096	1.91	G
63	331684	6/26/92	10:20:18.4	67.8983	32.5692	1.85	G
74	342462	10/30/92	11:10:58.2	67.9684	32.9856	1.56	G
76	344520	11/27/92	11:48:07.7	67.9608	32.7741	2.13	G
78	346745	12/30/92	11:30:58.9	67.9414	32.4985	2.55	G
2	3019	11/21/90	03:24:43.8	67.3130	32.7322	1.90	H

Table 55: Sorted events for area 17

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
8	17469	4/9/91	19:23:23.3	67.3133	32.8876	1.59	H
19	24962	6/2/91	05:43:55.0	67.3791	32.8839	1.50	H
34	41087	9/22/91	05:36:34.3	67.3635	32.7194	1.59	H
37	41835	9/29/91	08:09:19.1	67.4009	32.8783	1.64	H
42	302043	11/26/91	01:18:52.8	67.2439	32.9204	1.57	H
46	313080	1/25/92	02:07:04.6	67.3471	32.9527	1.64	H
49	321773	3/7/92	18:42:55.7	67.1719	32.7975	1.73	H
53	325804	4/3/92	19:31:20.1	67.5003	32.9578	1.56	H
54	325214	4/18/92	19:06:37.8	67.7645	32.5631	1.51	H
62	331551	6/24/92	20:42:15.8	67.6843	32.4549	1.68	H
64	332714	7/8/92	18:26:19.0	67.1228	32.7396	1.70	H

Remarks:

- No mine has been reported in the Helsinki bulletin for this area despite the location of three mine on SPOT photos.
- The five events reported in the Helsinki bulletin were identified as coming from mines HD9 and HK1 located in area 16. Four of them could be Sorted into groups B or C of area 16. The remaining event, 35, is more questionable.
- The events are systematically located too close to the ARCESS array with respect to the mine locations as already observed for other areas in the Kola Peninsula.

Mine and event locations:

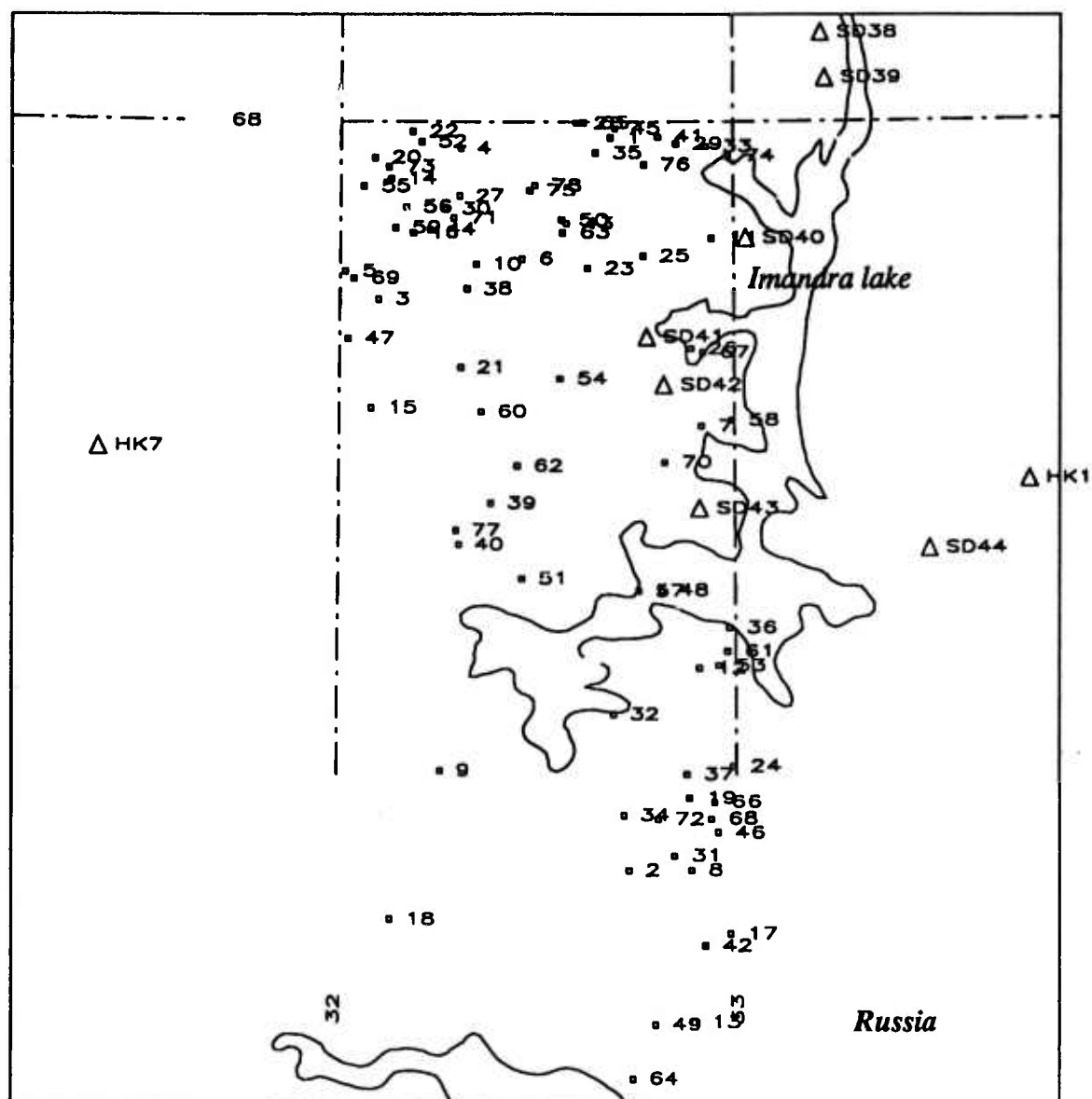


Figure 18: Mine and IMS event locations for area 17.

AREA 18

Latitude: 66 - 67°N

Longitude: 32 - 34°E

Local magnitude range: -

Reported mine locations: None

Number of events in IMS2: 27

Number of events within the magnitude range: 27

Number of processed events: 18

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 10s. before P, 90s. after P

Number of reference events: 1

Table 56: Reference events for area 18

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
4	14581	712076	504530	0.84	A

Number of events found in the Helsinki bulletin: 2

Table 57: Events found in the Helsinki bulletin for area 18

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
2	10066	11/29/90	13:32:56.9	1.60	HD9		EXP	-
9	32649	7/30/91	02:19:18.9	2.03	66.71	33.05	P.E.	-

Events with the most reliable classification:

Table 58: Sorted events for area 18

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
3	6324	1/8/91	12:07:24.9	66.4845	33.2041	1.45	A
4	14581	3/21/91	12:52:32.8	66.4421	33.7975	1.25	A
5	15973	3/28/91	12:50:01.4	66.5656	33.9739	1.20	A
6	18206	4/15/91	12:38:47.8	66.5317	33.7563	1.23	A
15	338270	9/9/92	11:18:55.5	66.3282	33.2949	1.30	A
17	342475	10/30/92	12:20:43.2	66.3950	33.6074	1.29	A

Remarks:

- Only a few events show similarities. As shown on Figure 19, their locations cover an area of 40 x 40 km. The other events have scattered locations.

Mine and event locations:

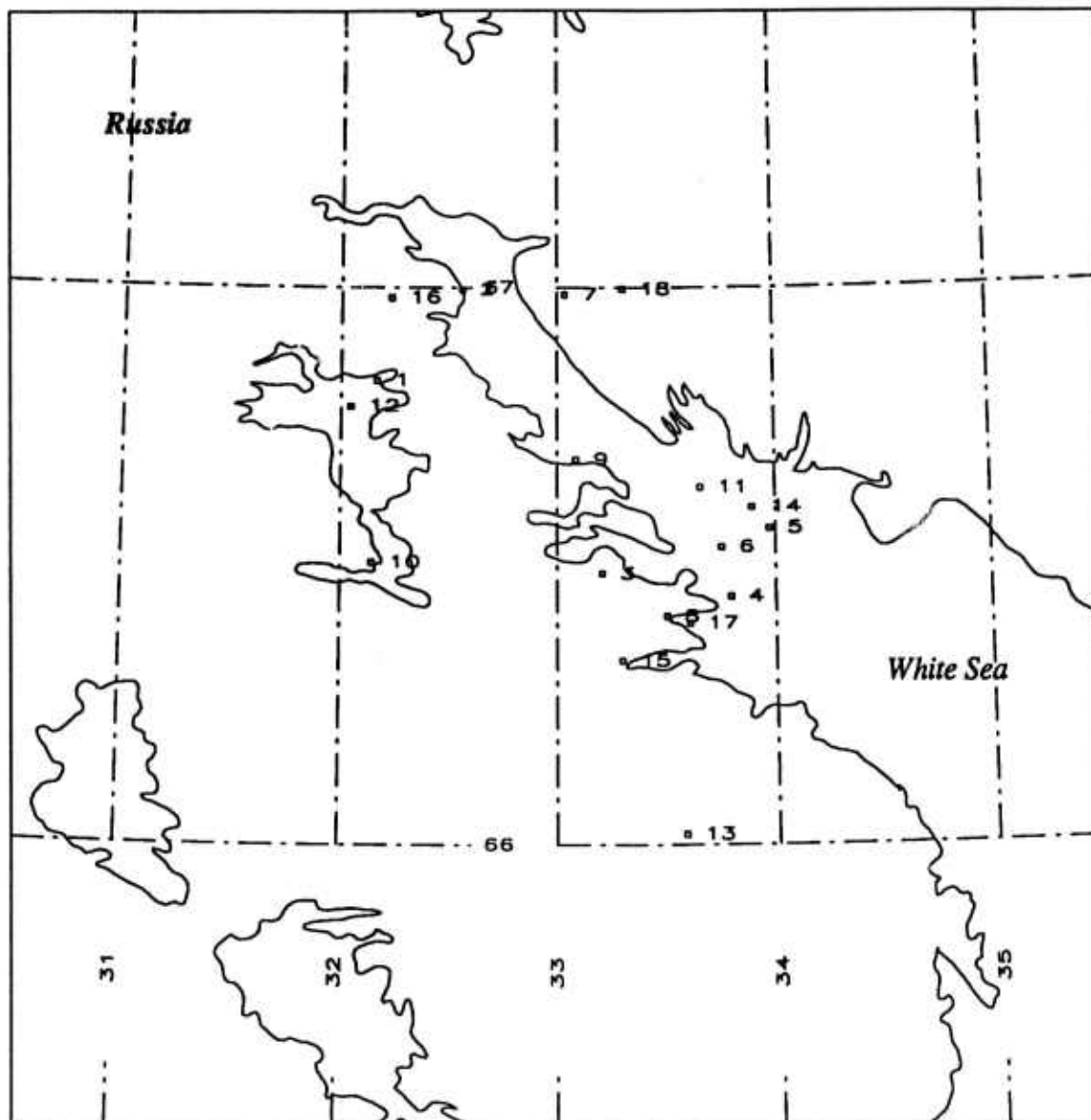


Figure 19: Mine and IMS event locations for area 18.

AREA 19

Latitude: 66 - 68 °N

Longitude: 30 - 32 °E

Local magnitude range: > 2.0

Number of events in IMS2: 309

Number of events within the magnitude range: 73

Number of processed events: 66

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 6s. before P, 56s. after P

Number of reference events: 4

Table 59: Reference events for area 19

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
9	15006	707690	493689	0.75	A
32	301141	1004086	1434919	0.76	B
8	14388	704547	484294	0.78	C
26	33671	874139	1074977	0.80	D

Reported mine locations:

Table 60: Mine locations for area 19

Label	Latitude °N	Longitude °E	Origin
JOG69	67.55	30.33	JOG
HK8	67.56	30.44	HELS
HD1	67.6	30.5	old_HELS
HD3	67.7	31.4	old_HELS
HK7	67.7	31.4	HELS

Number of events found in the Helsinki bulletin: 51

Table 61: Events found in the Helsinki bulletin for area 19

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
3	10051	11/29/90	12:51:55.7	2.01	67.45	32.51	-	-
10	15007	3/16/91	12:00:39.6	2.19	HD1		EXP	-
11	16295	3/23/91	11:46:34.3	2.08	HD1		EXP	-
6	5216	12/22/90	13:07:52.0	2.19	HD1		EXP	A
40	302446	12/8/91	12:42:15.5	2.42	HK8		EXP	A
42	302736	12/14/91	13:36:34.7	2.18	HK8		EXP	A
51	323617	3/28/92	11:08:32.6	2.19	HK8		EXP	A
1	3114	11/6/90	09:43:50.8	2.28	HD1		EXP	B
12	16762	3/30/91	12:13:34.0	2.04	HD1		EXP	B
18	22804	5/15/91	12:33:17.8	2.05	HD1		EXP	B
20	24291	5/25/91	10:56:12.6	2.03	HD1		EXP	B
32	301141	11/2/91	12:38:12.7	2.35	HK8		EXP	B
39	302445	12/8/91	12:41:47.4	2.39	HK8		EXP	B
41	302735	12/14/91	13:36:12.9	2.00	HK8		EXP	B
8	14388	3/13/91	13:30:26.8	2.10	HK7		EXP	C
35	301418	11/7/91	10:55:19.7	2.16	HK7		EXP	C
59	340241	9/27/92	05:22:44.1	2.32	67.62	33.82	-	C
2	2296	11/17/90	11:32:57.7	2.12	HD1		EXP	D
4	8144	12/15/90	12:36:56.3	2.07	HD1		EXP	D
5	314447	12/22/90	13:06:47.7	2.18	HD1		EXP	D
7	9113	1/26/91	11:40:07.8	2.12	HD1		EXP	D
15	20220	4/28/91	11:12:31.9	2.18	67.64	30.67	P. QB.	D
17	21211	5/8/91	12:10:44.7	2.22	HD1		EXP	D
19	26852	5/18/91	13:29:58.4	2.19	HD1		EXP	D
21	24946	6/1/91	12:30:43.1	2.19	HK8		EXP	D
22	25979	6/8/91	11:13:25.5	2.24	HK8		EXP	D
24	28201	6/29/91	12:49:48.3	2.15	HK8		EXP	D
26	33671	8/3/91	11:18:01.6	2.13	HK8		EXP	D

Table 61: Events found in the Helsinki bulletin for area 19

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
27	35253	8/10/91	09:35:11.9	2.15	HK8	EXP	D
29	38330	9/7/91	14:03:13.2	2.28	HK8	EXP	D
30	40735	9/21/91	11:58:44.1	2.40	HK8	EXP	D
31	300828	10/26/91	12:18:39.4	2.41	HK8	EXP	D
34	301388	11/6/91	12:36:26.8	2.06	HK8	EXP	D
36	301718	11/16/91	12:21:55.5	2.22	HK8	EXP	D
37	302123	11/23/91	12:38:19.3	2.34	HK8	EXP	D
38	302512	11/30/91	12:02:13.0	2.32	HK8	EXP	D
43	303233	12/21/91	12:57:35.2	2.16	HK8	EXP	D
44	312949	1/25/92	11:17:30.7	2.28	HK8	EXP	D
45	315461	2/1/92	11:46:08.8	2.46	HK8	EXP	D
46	317853	2/8/92	11:44:41.4	2.22	HK8	EXP	D
47	321768	3/7/92	11:44:32.5	2.11	HK8	EXP	D
48	322200	3/14/92	12:27:36.9	2.29	HK8	EXP	D
49	321679	3/21/92	11:03:15.4	2.13	HK8	EXP	D
50	323616	3/28/92	11:07:34.7	2.18	HK8	EXP	D
52	325198	4/18/92	11:10:41.9	2.29	HK8	EXP	D
53	328095	5/16/92	10:56:58.8	2.35	HK8	EXP	D
54	331758	6/27/92	09:44:24.8	2.19	HK8	EXP	D
55	333203	7/4/92	10:28:11.6	2.23	HK8	EXP	D
56	334068	7/22/92	11:36:27.1	2.07	HK8	EXP	D
57	335915	8/15/92	10:31:18.1	2.11	HK8	EXP	D
58	340207	9/26/92	09:59:52.0	2.08	HK8	EXP	D

Events with the most reliable classification:

Table 62: Sorted events for area 19

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
6 ^a	5216	12/22/90	13:07:52.0	67.6405	30.8792	2.19	A
9 ^a	15006	3/16/91	12:00:16.0	67.3904	31.3467	2.12	A
13 ^a	16763	3/30/91	12:14:00.4	67.4258	30.7352	2.17	A
16 ^a	20221	4/28/91	11:12:53.8	67.5873	30.7168	2.27	A
25 ^a	29262	7/6/91	11:28:39.6	67.6913	30.6059	2.23	A
28 ^a	36379	8/24/91	10:44:54.2	67.3461	31.2306	2.14	A
40 ^a	302446	12/8/91	12:42:15.5	67.3945	30.7778	2.42	A
42 ^a	302736	12/14/91	13:36:34.7	67.3901	30.9708	2.18	A
51 ^a	323617	3/28/92	11:08:32.6	67.6150	30.6927	2.19	A
65 ^a	346746	12/30/92	11:53:38.0	67.1349	31.7911	2.02	A
1 ^a	3114	11/6/90	09:43:50.8	67.5354	30.1250	2.28	B
12 ^a	16762	3/30/91	12:13:34.0	67.2688	30.9723	2.04	B
18 ^a	22804	5/15/91	12:33:17.8	67.6261	30.2151	2.05	B
20 ^a	24291	5/25/91	10:56:12.6	67.6001	30.3451	2.03	B
32 ^a	301141	11/2/91	12:38:12.7	67.6294	30.7797	2.35	B
33 ^a	301139	11/2/91	12:38:24.3	67.6662	30.3250	2.07	B
39 ^a	302445	12/8/91	12:41:47.4	67.5105	31.3541	2.39	B
41 ^a	302735	12/14/91	13:36:12.9	67.4881	30.6020	2.00	B
8	14388	3/13/91	13:30:26.8	67.5673	31.1427	2.10	C
35	301418	11/7/91	10:55:19.7	67.6300	30.9163	2.16	C
59	340241	9/27/92	05:22:44.1	67.8293	31.8541	2.32	C
2	2296	11/17/90	11:32:57.7	67.6589	30.4890	2.12	D
4	8144	12/15/90	12:36:56.3	67.5692	30.3822	2.07	D
5	314447	12/22/90	13:06:47.7	67.6126	30.6297	2.18	D
7	9113	1/26/91	11:40:07.8	67.6049	30.3330	2.12	D
14	17930	4/13/91	08:47:22.1	67.6307	30.7078	2.22	D
15	20220	4/28/91	11:12:31.9	67.6268	30.4870	2.18	D
17	21211	5/8/91	12:10:44.7	67.4339	30.4951	2.22	D

Table 62: Sorted events for area 19

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
19	26852	5/18/91	13:29:58.4	67.6289	30.3424	2.19	D
21	24946	6/1/91	12:30:43.1	67.5957	30.3680	2.19	D
22	25979	6/8/91	11:13:25.5	67.6858	30.6084	2.24	D
23	26914	6/22/91	12:08:21.8	67.8022	30.2418	2.14	D
24	28201	6/29/91	12:49:48.3	67.5265	30.2658	2.15	D
26	33671	8/3/91	11:18:01.6	67.6181	30.6171	2.13	D
27	35253	8/10/91	09:35:11.9	67.5748	30.3086	2.15	D
29	38330	9/7/91	14:03:13.2	67.5826	30.2219	2.28	D
30	40735	9/21/91	11:58:44.1	67.5725	30.3247	2.40	D
31	300828	10/26/91	12:18:39.4	67.5567	30.6610	2.41	D
34	301388	11/6/91	12:36:26.8	67.5170	30.6954	2.06	D
36	301718	11/16/91	12:21:55.5	67.6085	30.1428	2.22	D
37	302123	11/23/91	12:38:19.3	67.6013	30.3261	2.34	D
38	302512	11/30/91	12:02:13.0	67.6014	30.3716	2.32	D
43	303233	12/21/91	12:57:35.2	67.6500	30.9358	2.16	D
44	312949	1/25/92	11:17:30.7	67.5049	31.0197	2.28	D
45	315461	2/1/92	11:46:08.8	67.5922	30.2999	2.46	D
46	317853	2/8/92	11:44:41.4	67.6481	30.5943	2.22	D
47	321768	3/7/92	11:44:32.5	67.4958	30.5012	2.11	D
48	322200	3/14/92	12:27:36.9	67.5485	30.6805	2.29	D
49	321679	3/21/92	11:03:15.4	67.4826	30.9966	2.13	D
50	323616	3/28/92	11:07:34.7	67.6640	30.4040	2.18	D
52	325198	4/18/92	11:10:41.9	67.4510	30.7393	2.29	D
53	328095	5/16/92	10:56:58.8	67.4874	30.9323	2.35	D
54	331758	6/27/92	09:44:24.8	67.5063	30.8505	2.19	D
55	333203	7/4/92	10:28:11.6	67.5842	30.6047	2.23	D
56	334068	7/22/92	11:36:27.1	67.4343	30.7058	2.07	D
57	335915	8/15/92	10:31:18.1	67.6573	30.6733	2.11	D
58	340207	9/26/92	09:59:52.0	67.5543	30.7849	2.08	D
60	340694	10/3/92	11:25:35.2	67.5388	30.5184	2.20	D

Table 62: Sorted events for area 19

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
61	341710	10/17/92	12:13:37.1	67.6038	30.7467	2.30	D
62	344396	11/21/92	12:20:18.4	67.6088	30.7390	2.16	D
63	344579	11/28/92	12:44:00.1	67.6990	30.2048	2.22	D
64	345395	12/12/92	11:37:19.2	67.5255	31.1794	2.17	D
66	345753	12/30/92	11:54:06.5	67.5170	30.4885	2.04	D

a. Mixed events**Remarks:**

- Only two events were reported in the Helsinki bulletin as coming from mine HK7 and they are the only events within group C.
- The events from groups A, B and D are identified in the Helsinki bulletin as originating from mine HK8 (HD1) only. This is probably true since events from group A, B and D show similarities.

Mine and event locations:

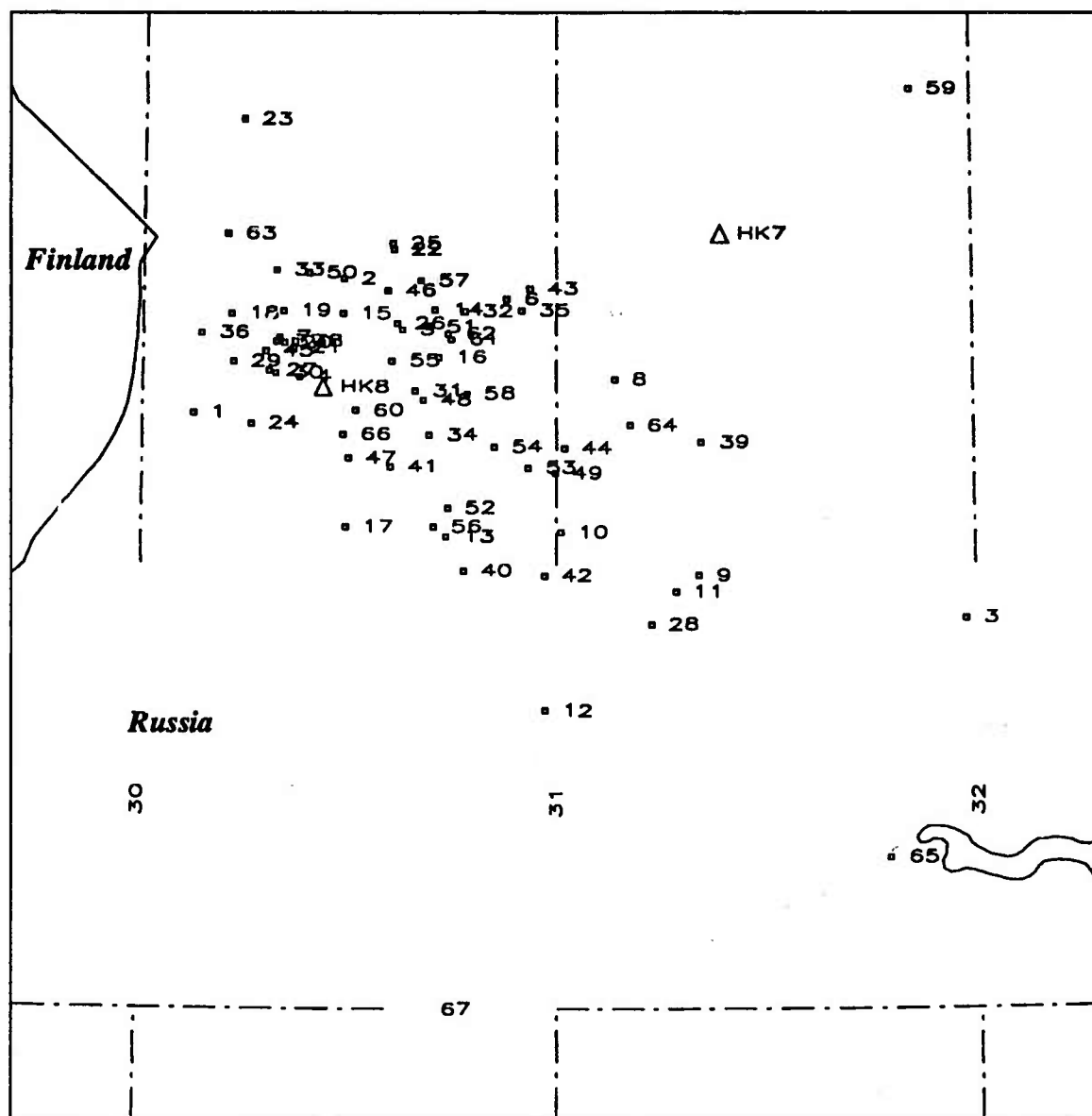


Figure 20: Mine and IMS event locations for area 19.

AREA 20

Latitude: 66 - 68°N

Longitude: 26 - 30°E

Local magnitude range: 0.5

Reported mine locations: None

Number of events in IMS2: 117

Number of events within the magnitude range: 103

Number of processed events: 91

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 5s. before P, 45s. after P

Number of reference events: 7

Table 63: Reference events for area 20

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
39	30083	842292	979553	0.46	A
76	337343	1413725	2619369	0.84	B
16	12936	621303	1376188	0.79	C
33	21201	775173	760518	0.92	D
84	341310	1469414	2762382	0.78	E
78	337790	1423068	2641101	0.88	F
18	12657	698108	460499	0.76	G

Number of events found in the Helsinki bulletin: 30

Table 64: Events found in the Helsinki bulletin for area 20

Event #	IMS orid	IMS origin time		IMS ml	IMS location		HEL lab	Group
23	15108	3/20/91	11:58:11.6	1.31	HA25		EXP	-
26	15573	3/22/91	17:52:19.9	1.22	66.01	28.91	P.E.	-
35	23422	5/20/91	17:00:50.2	1.50	HA25		EXP	-
46	35981	8/22/91	17:03:29.1	1.48	HM22		EXP	-
50	40875	9/21/91	20:59:43.3	1.28	66.04	28.78	-	-
1	3115	11/6/90	09:44:05.6	2.50	HD1		EXP	A
2	5265	11/14/90	13:08:34.2	2.05	HD1		EXP	A
7	8107	11/24/90	11:54:18.4	2.01	HD1		EXP	A

Table 64: Events found in the Helsinki bulletin for area 20

Event #	IMS orid	IMS origin time		IMS ml	IMS location		HEL lab	Group
30	16837	4/5/91	12:52:45.4	1.76	HD1		EXP	A
34	22806	5/15/91	12:33:33.3	2.17	HD1		EXP	A
37	28300	6/26/91	12:12:53.7	1.33	HK8		EXP	A
66	329362	5/30/92	11:11:09.2	2.47	HK8		EXP	A
68	330216	6/11/92	11:00:44.9	1.65	HK8		EXP	A
69	331597	6/25/92	11:31:36.7	1.42	HK8		EXP	A
9	313994	12/8/90	13:19:44.5	1.44	HD1		EXP	B
38	29263	7/6/91	11:28:24.7	1.88	HK8		EXP	B
54	303099	12/28/91	12:43:45.5	1.53	HK8		EXP	B
56	317915	2/22/92	11:46:12.7	1.87	HK8		EXP	B
61	324899	4/11/92	10:48:00.2	1.80	HK8		EXP	B
72	333695	7/18/92	09:39:22.8	1.78	HK8		EXP	B
76	337343	8/29/92	09:58:30.8	2.15	67.63	30.62	-	B
81	339273	9/19/92	10:13:11.8	1.65	HK8		EXP	B
16	12936	2/6/91	13:06:46.5	2.20	HD1		EXP	C
62	325188	4/18/92	08:14:19.6	1.27	HK8		EXP	C
15	12935	2/6/91	13:06:18.6	2.01	HD1		EXP	E
49	37659	9/1/91	10:14:57.0	1.30	67.93	26.01	-	F
75	337141	8/27/92	10:14:53.3	1.44	67.93	25.87	-	F
77	337483	8/31/92	13:04:51.5	1.33	67.93	25.97	-	F
78	337790	9/3/92	12:59:53.2	1.27	67.94	25.94	-	F
79	338084	9/7/92	10:59:50.8	1.44	67.95	26.06	-	F
10	9950	12/21/90	20:14:02.4	1.15	HD1		EXP	G

Events with the most reliable classification:

Table 65: Sorted events for area 20

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
1	3115	11/6/90	09:44:05.6	67.5694	29.8671	2.50	A
2	5265	11/14/90	13:08:34.2	67.5470	29.7919	2.05	A

Table 65: Sorted events for area 20

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
5	2455	11/22/90	12:32:11.7	67.6140	29.8259	0.94	A
7	8107	11/24/90	11:54:18.4	67.5674	29.7596	2.01	A
11	7019	12/28/90	10:14:45.5	67.5594	29.8966	0.89	A
14	10030	1/31/91	12:40:14.0	67.4846	29.8443	0.95	A
19	13492	3/7/91	12:06:30.7	67.6171	29.9658	1.23	A
30	16837	4/5/91	12:52:45.4	67.6830	29.6453	1.76	A
34	22806	5/15/91	12:33:33.3	67.5872	29.8286	2.17	A
36	23993	5/24/91	12:19:36.6	67.6782	29.5765	0.79	A
37	28300	6/26/91	12:12:53.7	67.6591	29.9771	1.33	A
39	30083	7/12/91	12:36:54.7	67.6569	29.9246	1.01	A
47	36184	8/23/91	19:39:54.9	67.7504	29.9168	0.96	A
66	329362	5/30/92	11:11:09.2	67.6550	29.9576	2.47	A
68	330216	6/11/92	11:00:44.9	67.7777	29.9944	1.65	A
69	331597	6/25/92	11:31:36.7	67.6728	29.6933	1.42	A
85	342311	10/28/92	12:45:28.3	67.7459	29.3438	1.48	A
8	313989	12/8/90	12:15:37.6	67.6261	29.7815	2.07	B
9	313994	12/8/90	13:19:44.5	67.9540	29.5236	1.44	B
32	19452	4/20/91	10:45:30.4	67.6358	29.9029	1.95	B
38	29263	7/6/91	11:28:24.7	67.6704	29.9737	1.88	B
54	303099	12/28/91	12:43:45.5	67.9682	29.4580	1.53	B
56	317915	2/22/92	11:46:12.7	67.4849	29.5292	1.87	B
61	324899	4/11/92	10:48:00.2	67.5804	29.8307	1.80	B
63	325199	4/18/92	11:10:04.8	67.7791	29.8907	1.23	B
72	333695	7/18/92	09:39:22.8	67.6332	29.6728	1.78	B
76	337343	8/29/92	09:58:30.8	67.6251	29.9220	2.15	B
81	339273	9/19/92	10:13:11.8	67.7582	29.8930	1.65	B
87	342520	10/31/92	11:26:43.0	67.5879	29.8548	2.38	B
16	12936	2/6/91	13:06:46.5	66.9877	28.2508	2.20	C
62	325188	4/18/92	08:14:19.6	67.8806	29.8645	1.27	C
88	344395	11/21/92	12:21:14.9	67.6246	29.6927	1.98	C

Table 65: Sorted events for area 20

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
33	21201	5/8/91	11:12:47.7	67.7340	29.7692	0.90	D
44	35608	8/20/91	12:34:54.2	67.6215	29.9763	1.15	D
12	5865	1/4/91	00:39:06.2	67.8790	27.1918	0.61	E
15	12935	2/6/91	13:06:18.6	67.5781	29.9892	2.01	E
40	31385	7/21/91	15:04:15.4	67.9286	26.6405	0.69	E
60	324958	4/7/92	19:09:49.1	67.7449	27.4104	0.99	E
64	327071	5/6/92	05:29:53.6	67.9094	26.8559	0.58	E
84	341310	10/14/92	07:59:42.5	67.7171	27.3552	0.92	E
86	342349	10/28/92	15:43:18.5	67.7674	27.1086	1.03	E
90	344426	11/24/92	00:12:33.8	67.6312	27.4725	1.05	E
49	37659	9/1/91	10:14:57.0	67.8076	26.0527	1.30	F
75	337141	8/27/92	10:14:53.3	67.5075	26.3537	1.44	F
77	337483	8/31/92	13:04:51.5	67.4948	26.0983	1.33	F
78	337790	9/3/92	12:59:53.2	67.4992	26.1018	1.27	F
79	338084	9/7/92	10:59:50.8	67.3058	26.0671	1.44	F
80	338614	9/12/92	06:44:53.5	67.5379	26.0076	1.12	F
6	3368	11/23/90	19:47:24.6	67.6271	29.6660	1.12	G
10	9950	12/21/90	20:14:02.4	67.7103	29.7318	1.15	G
17	13177	3/6/91	10:48:29.7	67.4264	26.7903	0.85	G
18	12657	3/7/91	10:51:47.8	67.5347	26.7772	1.03	G
20	13145	3/11/91	15:11:21.2	67.5321	26.6901	0.90	G
21	15260	3/18/91	13:12:25.4	67.4613	26.7266	0.95	G
22	14272	3/19/91	13:08:15.4	67.5279	26.6556	0.91	G
24	14357	3/20/91	12:38:33.0	67.4291	26.7202	0.95	G
25	14575	3/21/91	12:41:39.3	67.4542	26.5915	0.56	G
27	14989	3/25/91	12:35:23.7	67.5329	26.7193	0.88	G
28	15992	4/2/91	11:21:34.9	67.4770	26.5755	0.84	G
29	16156	4/4/91	09:46:41.3	67.4926	26.5504	0.59	G
31	16579	4/8/91	11:55:34.1	67.5082	26.4814	0.60	G
41	31145	7/24/91	10:25:17.6	67.6625	29.8420	1.18	G

Table 65: Sorted events for area 20

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
45	35870	8/22/91	12:33:51.2	67.5714	29.6396	0.93	G
70	331744	6/27/92	02:37:39.5	67.1145	29.4521	1.30	G

Remarks:

- Based on the classification and on the IMS locations, these events seem to come from four main regions (Figure 21): groups A, B, C and D from the North-East; group E from the North-West; groups F and G from the West; the unsorted events that are characterized by small and/or mixed events are located in the South.
- The classification is consistent with the identification found in the Helsinki bulletin. This shows that the events from groups A, B, C and D have biased locations which are too close to the ARCESS array.

Mine and event locations:

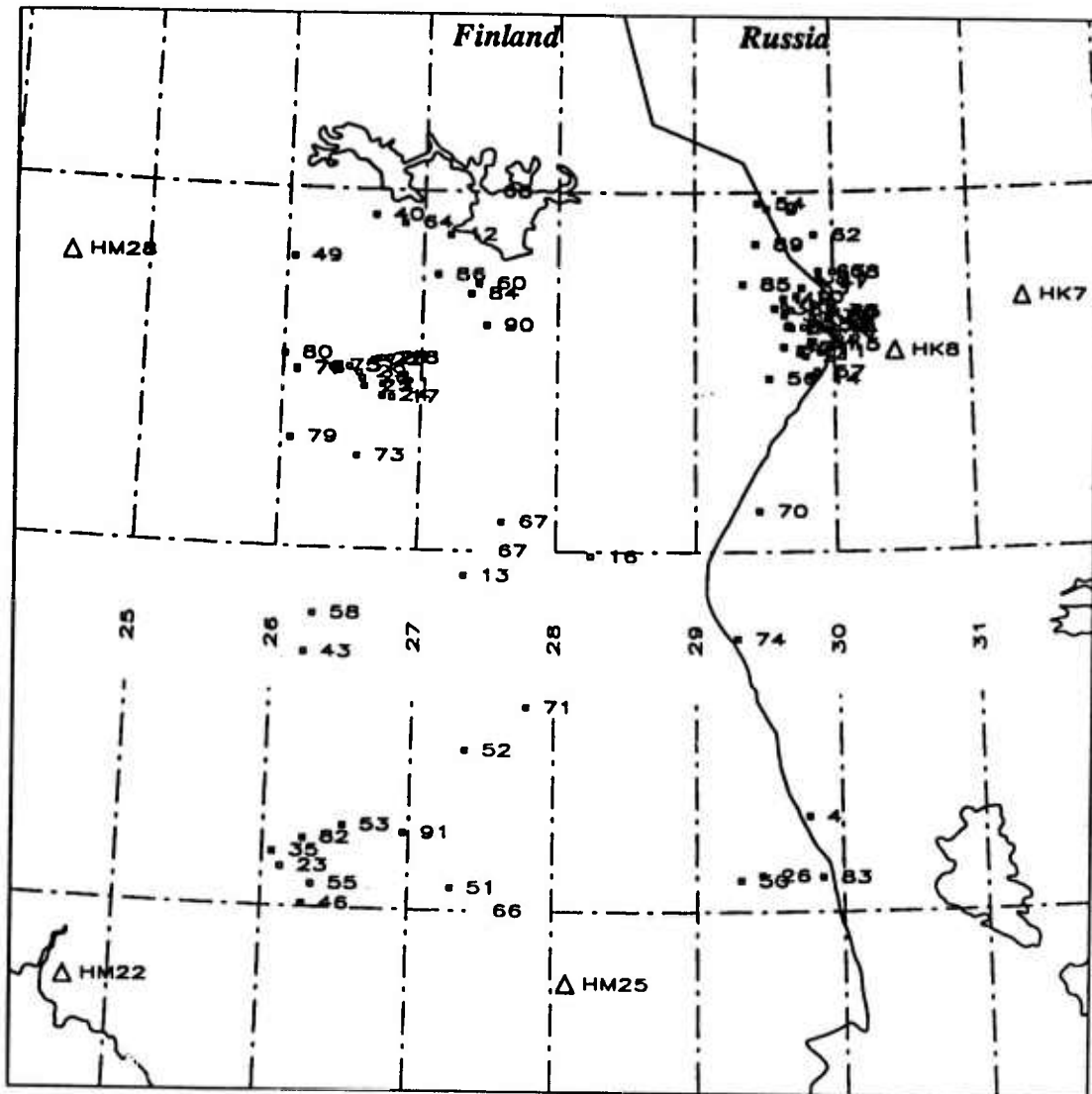


Figure 21: Mine and IMS event locations for area 20.

AREA 21

Latitude: 66 - 68°N

Longitude: 22 - 26°E

Local magnitude range: > 1.0

Number of events in IMS2: 814

Number of events within the magnitude range: 123

Number of processed events: 115

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 8s. before P, 68s. after P

Number of reference events: 11

Table 66: Reference events for area 21

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
65	312913	1031014	1606780	0.78	A
104	340334	1448695	2723175	0.79	B
92	336850	1403166	2603469	0.79	C
46	35046	890751	1114679	0.85	D
25	18729	738242	588439	0.81	E
19	15255	709378	516029	0.82	F
89	334661	1370512	2420233	0.80	G
61	303001	1012005	1531641	0.80	H
94	337224	1413336	2615259	0.81	I
37	337460	1414133	2624283	0.81	J
68	312559	1034389	1650932	-	K

Reported mine locations:

Table 67: Mine locations for area 21

Label	Latitude °N	Longitude °E	Origin
HM28	67.79	24.43	HELS
N108	67.78999	24.43000	NORW

Number of events found in the Helsinki bulletin: 58

Table 68: Events found in the Helsinki bulletin for area 21

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
37	26123	6/12/91	10:56:26.3	1.38	HM22		EXP	-
42	30127	7/13/91	01:42:20.7	2.19	68.01	23.46	EART	-
45	35046	8/15/91	17:00:39.6	1.25	HM22		EXP	-
55	300946	10/30/91	17:10:31.6	1.39	HR1		EXP	-
71	321671	3/12/92	16:03:41.9	1.11	HM22		EXP	-
27	18644	4/17/91	17:47:29.0	2.11	67.02	24.56	EART	-
29	20294	4/30/91	00:17:41.6	1.10	67.82	22.64	P.E.	-
66	313137	1/10/92	07:46:35.5	2.44	67.22	23.57	EART	-
70	319341	2/29/92	20:30:48.4	1.80	67.83	22.43	P.E.	-
101	338033	9/6/92	12:29:54.0	1.08	67.95	25.79	-	-
31	21862	5/7/91	15:27:26.4	1.13	HA25		EXP	A
56	300972	10/31/91	12:04:50.3	1.45	HM22		EXP	A
57	301199	11/5/91	16:15:55.6	1.18	HM22		EXP	A
58	301445	11/7/91	18:05:16.3	1.25	HM22		EXP	A
65	312913	12/31/91	16:00:58.7	1.13	HM22		EXP	A
67	313163	1/13/92	18:09:22.6	1.27	HM22		EXP	A
79	328743	5/22/92	15:22:14.1	1.37	HM22		EXP	A
86	332902	7/10/92	13:45:31.4	1.19	HM22		EXP	A
87	334098	7/22/92	18:16:51.4	1.10	HM22		EXP	A
102	338571	9/11/92	18:55:21.0	1.01	HM22		EXP	A
16	14292	3/12/91	18:00:51.2	1.42	HA25		EXP	B
20	15472	3/22/91	11:54:39.0	1.63	HA25		EXP	B
22	15045	3/25/91	18:02:26.0	1.14	HA25		EXP	B
24	16161	4/4/91	10:56:27.6	1.24	HA25		EXP	B
26	18922	4/18/91	11:03:14.8	1.29	HA25		EXP	B
28	19322	4/25/91	17:37:19.0	1.27	HA25		EXP	B
32	22317	5/8/91	18:50:37.3	1.49	HA25		EXP	B
36	25871	6/7/91	10:58:29.4	1.51	HM22		EXP	B

Table 68: Events found in the Helsinki bulletin for area 21

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
43	33097	8/5/91	17:07:09.5	1.52	HM22		EXP	B
44	35153	8/9/91	16:58:41.9	1.32	HM22		EXP	B
49	39335	9/10/91	17:12:16.4	1.08	HM22		EXP	B
63	303149	12/19/91	18:00:53.5	1.15	HM22		EXP	B
81	329790	6/4/92	15:00:32.7	1.19	HM22		EXP	B
91	336484	8/20/92	15:01:01.1	1.11	HM22		EXP	B
104	340334	9/28/92	18:01:55.1	1.64	HM22		EXP	B
39	27095	6/24/91	18:54:52.2	1.88	HM22		EXP	C
53	40901	9/19/91	11:01:14.9	1.15	HM22		EXP	C
64	303479	1/8/92	18:34:55.2	1.39	HM22		EXP	C
84	331622	6/25/92	15:29:37.6	1.96	HR3		EXP	C
85	332010	6/30/92	11:01:27.7	1.39	HM22		EXP	C
92	336850	8/24/92	17:02:20.3	1.11	HM22		EXP	C
23	15748	3/27/91	16:37:02.7	1.20	HE1		EXP	E
25	18729	4/15/91	19:10:59.8	1.74	HE1		EXP	E
38	27183	6/19/91	15:29:48.1	1.15	67.01	20.52	-	E
54	41661	9/25/91	15:44:24.0	1.65	HR1		EXP	E
59	301360	11/11/91	16:46:04.5	1.35	HR1		EXP	E
6	26448	11/28/90	15:01:40.6	1.70	HE1		EXP	G
7	9535	11/28/90	15:01:47.2	1.64	HE1		EXP	G
13	9420	1/29/91	22:30:01.8	1.74	HE1		EXP	G
14	13837	3/11/91	18:13:25.8	1.85	HE1		EXP	G
15	13838	3/12/91	07:23:20.4	1.82	66.85	22.76	P.E.	G
98	337805	9/3/92	15:29:13.0	1.17	HR3		EXP	G
99	337815	9/3/92	16:16:42.8	1.04	HR3		EXP	G
93	337970	8/26/92	12:44:59.8	1.28	67.94	25.96	-	J
95	337263	8/28/92	12:00:01.0	1.08	67.92	25.75	-	J
96	337410	8/30/92	12:59:52.9	1.18	67.93	25.69	-	J
97	337460	8/31/92	09:30:00.4	1.43	67.93	25.82	-	J
100	337987	9/5/92	10:20:01.2	1.53	67.92	25.59	-	J

Events with the most reliable classification:

Table 69: Sorted events for area 21

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
31	21862	5/7/91	15:27:26.4	66.0375	25.0829	1.13	A
34	24553	5/30/91	09:00:16.9	66.5716	24.5703	1.05	A
50	39509	9/13/91	14:55:04.0	66.0925	25.9938	1.06	A
56	300972	10/31/91	12:04:50.3	66.0159	25.6200	1.45	A
57	301199	11/5/91	16:15:55.6	66.1202	25.4525	1.18	A
58	301445	11/7/91	18:05:16.3	66.0083	25.5527	1.25	A
65	312913	12/31/91	16:00:58.7	66.0713	25.7580	1.13	A
67	313163	1/13/92	18:09:22.6	66.0026	25.4606	1.27	A
71	321671	3/12/92	16:03:41.9	66.1811	24.9700	1.11	A
72	321671	3/12/92	16:03:41.9	66.1811	24.9700	1.11	A
73	322227	3/17/92	15:27:13.3	66.0033	24.1831	1.15	A
79	328743	5/22/92	15:22:14.1	66.0197	24.6722	1.37	A
86	332902	7/10/92	13:45:31.4	66.4446	24.9708	1.19	A
87	334098	7/22/92	18:16:51.4	66.0196	24.8275	1.10	A
90	335595	8/11/92	15:02:43.0	66.0094	24.7375	1.18	A
102	338571	9/11/92	18:55:21.0	66.0562	25.2360	1.01	A
110	344450	11/24/92	12:48:52.3	66.0366	25.0288	1.02	A
114	347172	1/5/93	11:57:53.1	66.1243	24.8754	1.50	A
16	14292	3/12/91	18:00:51.2	66.3539	25.6981	1.42	B
20	15472	3/22/91	11:54:39.0	66.0066	24.8602	1.63	B
22	15045	3/25/91	18:02:26.0	66.1223	25.2309	1.14	B
24	16161	4/4/91	10:56:27.6	66.1953	25.4421	1.24	B
26	18922	4/18/91	11:03:14.8	66.0460	25.7576	1.29	B
28	19322	4/25/91	17:37:19.0	66.2258	24.6419	1.27	B
32	22317	5/8/91	18:50:37.3	66.2048	24.7148	1.49	B
36	25871	6/7/91	10:58:29.4	66.0685	25.0161	1.51	B
43	33097	8/5/91	17:07:09.5	66.1411	25.0899	1.52	B
44	35153	8/9/91	16:58:41.9	66.0184	25.2827	1.32	B

Table 69: Sorted events for area 21

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
49	39335	9/10/91	17:12:16.4	66.3678	25.3782	1.08	B
63	303149	12/19/91	18:00:53.5	66.2039	25.8812	1.15	B
81	329790	6/4/92	15:00:32.7	66.1832	25.6837	1.19	B
91	336484	8/20/92	15:01:01.1	66.0278	25.1700	1.11	B
104	340334	9/28/92	18:01:55.1	66.1737	24.8420	1.64	B
106	341059	10/5/92	16:09:54.3	66.0829	25.2427	1.31	B
1	3211	11/20/90	13:49:33.3	67.0553	22.0287	1.04	C
8	10244	12/3/90	14:02:10.2	66.7723	25.8498	1.20	C
30	20299	4/30/91	06:45:40.1	66.0925	23.0123	1.10	C
39	27095	6/24/91	18:54:52.2	66.0894	25.7898	1.88	C
53	40901	9/19/91	11:01:14.9	66.0452	24.9380	1.15	C
64	303479	1/8/92	18:34:55.2	66.5126	25.2752	1.39	C
84	331622	6/25/92	15:29:37.6	67.1179	22.6668	1.96	C
85	332010	6/30/92	11:01:27.7	66.3011	24.9916	1.39	C
92	336850	8/24/92	17:02:20.3	66.6516	24.6557	1.11	C
109	342491	10/30/92	15:56:59.5	66.8492	25.3489	1.12	C
111	344462	11/24/92	18:02:45.2	66.1122	25.1377	1.34	C
45	35046	8/15/91	17:00:39.6	66.1553	24.2870	1.25	D
46	35046	8/15/91	17:00:39.6	66.1553	24.2870	1.25	D
115	347452	1/8/93	18:16:42.8	66.5492	24.9060	1.33	D
23	15748	3/27/91	16:37:02.7	66.9959	22.4044	1.20	E
25	18729	4/15/91	19:10:59.8	67.1566	22.1346	1.74	E
33	22785	5/10/91	14:15:18.7	67.1328	22.3370	1.55	E
38	27183	6/19/91	15:29:48.1	67.0216	22.2439	1.15	E
54	41661	9/25/91	15:44:24.0	67.1491	22.0271	1.65	E
59	301360	11/11/91	16:46:04.5	67.1778	22.3509	1.35	E
69	321012	2/28/92	16:30:36.2	67.4949	22.5213	1.10	E
19	15255	3/18/91	12:04:09.1	66.5992	25.5331	1.18	F
21	15566	3/22/91	15:56:42.6	66.6434	24.3630	1.35	F
113	345122	12/7/92	16:04:54.0	66.2941	24.8471	1.51	F

Table 69: Sorted events for area 21

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
5	8545	11/27/90	15:05:21.3	67.1990	22.3972	1.03	G
6	26448	11/28/90	15:01:40.6	67.1330	22.2295	1.70	G
7	9535	11/28/90	15:01:47.2	67.1518	22.1461	1.64	G
13	9420	1/29/91	22:30:01.8	67.1518	22.4506	1.74	G
14	13837	3/11/91	18:13:25.8	67.1180	22.2211	1.85	G
15	13838	3/12/91	07:23:20.4	66.8603	22.8354	1.82	G
51	40183	9/17/91	15:29:42.4	66.9951	22.1662	1.15	G
78	326157	4/26/92	21:58:50.5	67.5767	22.0625	1.01	G
82	330000	6/8/92	22:12:43.5	67.5434	22.0519	1.01	G
89	334661	7/29/92	22:00:50.0	67.1408	22.0786	1.08	G
98	337805	9/3/92	15:29:13.0	67.3471	22.1336	1.17	G
99	337815	9/3/92	16:16:42.8	67.4863	22.0839	1.04	G
105	340711	10/3/92	22:43:48.8	67.5472	22.1639	1.03	G
108	341232	10/13/92	03:05:12.5	67.1461	22.3708	1.32	G
9	4977	12/26/90	22:54:32.3	67.3423	22.0070	1.11	H
10	6292	1/7/91	22:49:46.1	67.2815	22.4039	1.17	H
52	40464	9/18/91	21:21:46.9	67.0713	22.2806	1.06	H
60	302918	12/16/91	23:02:50.3	67.4503	22.0743	1.02	H
61	303001	12/18/91	22:59:32.4	67.3749	22.1065	1.14	H
75	322059	3/23/92	23:01:54.8	67.1080	22.1634	1.00	H
77	325980	4/25/92	10:49:34.2	66.9116	23.0270	1.02	H
80	328883	5/25/92	01:49:55.1	67.2515	22.0064	1.02	H
3	3279	11/22/90	22:27:31.4	67.7344	22.2882	1.08	I
35	25103	6/2/91	22:14:44.1	67.2076	22.1526	1.07	I
83	331462	6/23/92	21:58:44.6	67.4592	22.0466	1.13	I
94	317224	8/28/92	07:04:52.1	67.5046	22.0215	1.00	I
107	340946	10/7/92	15:46:29.9	67.2098	22.0586	2.28	I
47	37702	9/3/91	11:59:59.3	67.8290	25.8428	1.09	J
48	37300	9/4/91	09:00:00.9	67.9443	25.8188	1.27	J
68	312559	1/21/92	08:08:33.8	67.9210	24.3297	1.16	J

Table 69: Sorted events for area 21

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
93	337970	8/26/92	12:44:59.8	67.9396	25.8852	1.28	J
95	337263	8/28/92	12:00:01.0	67.9941	25.7881	1.08	J
96	337410	8/30/92	12:59:52.9	67.4921	25.7124	1.18	J
97	337460	8/31/92	09:30:00.4	67.9984	25.7949	1.43	J
100	337987	9/5/92	10:20:01.2	67.9856	25.6863	1.53	J
68	312559	1/21/92	08:08:33.8	67.9210	24.3297	1.16	K

Remarks:

- A large number of events found in the Helsinki bulletin are located outside of this area. Most of them come from either area 23 (mines HE1, HR1, HR3) or from area 28 (mines HA25, HM22). This confirms the location bias already observed in the IMS locations for other areas.
- Three clusters can be seen in Figure 22: in the south, events from groups A, B, C and F seems to come from mine HM22 (HA2); in the West, events from groups E and G are identified in the Helsinki bulletin as coming either from mine HR1 or mine HR3; in the North-West, events from groups H and I have locations north of group G; events from group J are located in the North-East. The Helsinki bulletin did not assign any of the events from group J to a particular mine.
- One event from group G is identified as being an earthquake in the Helsinki bulletin while the other events are either originating from mines HR1 or HR3. The difference between the earthquake and the mining events is not obvious as is as the difference between events from mine HR1 and events from mine HR3. The variability of the signals within this group may be explained by the different origins of these events.
- Two-hundred-fifty-six events are located around the mine HM28 (between 67.5°N and 68°N and between 24°E and 25°E). Their local magnitude varies from 0.096 to 1.16 with 254 events with a local magnitude lower than 1.0. Event 68 is the only event for the mine that was included in the studied data set. No events from this mine were reported in the Helsinki bulletin.

1. *Chlorophyll a* (Chl a) is the primary photosynthetic pigment in most plants and algae. It is a green pigment that absorbs light energy and converts it into chemical energy. Chl a is found in the chloroplasts of plants and the thylakoids of algae. It is essential for the light-dependent reactions of photosynthesis, where it captures light energy and transfers it to the reaction center. Chl a is also involved in the regulation of photosynthesis and the response to environmental stress. It is a key component of the photosynthetic apparatus and is found in a wide range of organisms, from cyanobacteria to higher plants.



1. *Chlorophyll a* (Chl *a*)

2. *Chlorophyll b* (Chl *b*)

3. *Carotenoids* (Car)

4. *Phaeophytin a* (Phe *a*)

5. *Phaeophytin b* (Phe *b*)

6. *Phaeoerythrin* (Phe *e*)

7. *Phaeoxanthophyll* (Phe *x*)

8. *Phaeo-zeaxanthin* (Phe *z*)

9. *Phaeo-lutein* (Phe *l*)

10. *Phaeo-fucoerythrin* (Phe *f*)

11. *Phaeo-peridinin* (Phe *p*)

12. *Phaeo-zeaxanthin* (Phe *z*)

13. *Phaeo-lutein* (Phe *l*)

14. *Phaeo-fucoerythrin* (Phe *f*)

15. *Phaeo-peridinin* (Phe *p*)

16. *Phaeo-zeaxanthin* (Phe *z*)

17. *Phaeo-lutein* (Phe *l*)

18. *Phaeo-fucoerythrin* (Phe *f*)

19. *Phaeo-peridinin* (Phe *p*)

20. *Phaeo-zeaxanthin* (Phe *z*)

21. *Phaeo-lutein* (Phe *l*)

22. *Phaeo-fucoerythrin* (Phe *f*)

23. *Phaeo-peridinin* (Phe *p*)

24. *Phaeo-zeaxanthin* (Phe *z*)

25. *Phaeo-lutein* (Phe *l*)

26. *Phaeo-fucoerythrin* (Phe *f*)

27. *Phaeo-peridinin* (Phe *p*)

28. *Phaeo-zeaxanthin* (Phe *z*)

29. *Phaeo-lutein* (Phe *l*)

30. *Phaeo-fucoerythrin* (Phe *f*)

31. *Phaeo-peridinin* (Phe *p*)

32. *Phaeo-zeaxanthin* (Phe *z*)

33. *Phaeo-lutein* (Phe *l*)

34. *Phaeo-fucoerythrin* (Phe *f*)

35. *Phaeo-peridinin* (Phe *p*)

36. *Phaeo-zeaxanthin* (Phe *z*)

37. *Phaeo-lutein* (Phe *l*)

38. *Phaeo-fucoerythrin* (Phe *f*)

39. *Phaeo-peridinin* (Phe *p*)

40. *Phaeo-zeaxanthin* (Phe *z*)

41. *Phaeo-lutein* (Phe *l*)

42. *Phaeo-fucoerythrin* (Phe *f*)

43. *Phaeo-peridinin* (Phe *p*)

44. *Phaeo-zeaxanthin* (Phe *z*)

45. *Phaeo-lutein* (Phe *l*)

46. *Phaeo-fucoerythrin* (Phe *f*)

47. *Phaeo-peridinin* (Phe *p*)

48. *Phaeo-zeaxanthin* (Phe *z*)

49. *Phaeo-lutein* (Phe *l*)

50. *Phaeo-fucoerythrin* (Phe *f*)

51. *Phaeo-peridinin* (Phe *p*)

52. *Phaeo-zeaxanthin* (Phe *z*)

53. *Phaeo-lutein* (Phe *l*)

54. *Phaeo-fucoerythrin* (Phe *f*)

55. *Phaeo-peridinin* (Phe *p*)

56. *Phaeo-zeaxanthin* (Phe *z*)

57. *Phaeo-lutein* (Phe *l*)

58. *Phaeo-fucoerythrin* (Phe *f*)

59. *Phaeo-peridinin* (Phe *p*)

60. *Phaeo-zeaxanthin* (Phe *z*)

61. *Phaeo-lutein* (Phe *l*)

62. *Phaeo-fucoerythrin* (Phe *f*)

63. *Phaeo-peridinin* (Phe *p*)

64. *Phaeo-zeaxanthin* (Phe *z*)

65. *Phaeo-lutein* (Phe *l*)

66. *Phaeo-fucoerythrin* (Phe *f*)

67. *Phaeo-peridinin* (Phe *p*)

68. *Phaeo-zeaxanthin* (Phe *z*)

69. *Phaeo-lutein* (Phe *l*)

70. *Phaeo-fucoerythrin* (Phe *f*)

71. *Phaeo-peridinin* (Phe *p*)

72. *Phaeo-zeaxanthin* (Phe *z*)

73. *Phaeo-lutein* (Phe *l*)

74. *Phaeo-fucoerythrin* (Phe *f*)

75. *Phaeo-peridinin* (Phe *p*)

76. *Phaeo-zeaxanthin* (Phe *z*)

77. *Phaeo-lutein* (Phe *l*)

78. *Phaeo-fucoerythrin* (Phe *f*)

79. *Phaeo-peridinin* (Phe *p*)

80. *Phaeo-zeaxanthin* (Phe *z*)

81. *Phaeo-lutein* (Phe *l*)

82. *Phaeo-fucoerythrin* (Phe *f*)

83. *Phaeo-peridinin* (Phe *p*)

84. *Phaeo-zeaxanthin* (Phe *z*)

85. *Phaeo-lutein* (Phe *l*)

86. *Phaeo-fucoerythrin* (Phe *f*)

87. *Phaeo-peridinin* (Phe *p*)

88. *Phaeo-zeaxanthin* (Phe *z*)

89. *Phaeo-lutein* (Phe *l*)

90. *Phaeo-fucoerythrin* (Phe *f*)

91. *Phaeo-peridinin* (Phe *p*)

92. *Phaeo-zeaxanthin* (Phe *z*)

93. *Phaeo-lutein* (Phe *l*)

94. *Phaeo-fucoerythrin* (Phe *f*)

95. *Phaeo-peridinin* (Phe *p*)

96. *Phaeo-zeaxanthin* (Phe *z*)

97. *Phaeo-lutein* (Phe *l*)

98. *Phaeo-fucoerythrin* (Phe *f*)

99. *Phaeo-peridinin* (Phe *p*)

100. *Phaeo-zeaxanthin* (Phe *z*)

AREA 22

Latitude: 66 - 67°N

Longitude: 18 - 22°E

Local magnitude range: -

Reported mine locations: None

Number of events in IMS2: 76

Number of events within the magnitude range: 76

Number of processed events: 63

Frequency range used to process the data: 5 - 16 Hz

Processed signal length: 8s. before P, 68s. after P

Number of reference events: 5

Table 70: Reference events for area 22

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
43	337588	1422473	2628429	0.81	A
10	25494	804094	881646	0.8	B
62	345699	1536406	2886203	0.78	C
47	340339	1448693	2723136	0.79	D
53	342809	1501724	2807304	0.81	E

Number of events found in the Helsinki bulletin: 4

Table 71: Events found in the Helsinki bulletin for area 22

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
12	28474	7/1/91	15:39:16.6	1.71	HR1	EXP	B
13	31064	7/19/91	14:30:25.6	1.56	HR1	EXP	B
18	300865	10/28/91	16:30:29.0	1.87	HR1	EXP	B
22	302858	12/13/91	16:31:26.8	1.65	HR1	EXP	B

Events with the most reliable classification:

Table 72: Sorted events for area 22

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
1	5474	11/14/90	22:53:08.9	66.9704	21.3453	1.48	A
17	300770	10/24/91	22:54:11.3	66.9643	21.7687	1.00	A
23	303533	12/25/91	22:28:34.7	66.8343	21.1342	1.26	A
24	311935	1/9/92	23:08:56.4	66.2402	21.0287	1.39	A
32	327542	5/11/92	22:14:42.8	66.5705	20.9485	1.29	A
33	332723	7/8/92	21:54:27.2	66.9338	21.0630	1.06	A
36	335271	8/6/92	21:54:28.2	66.6701	20.9574	1.29	A
38	335353	8/7/92	21:59:18.3	66.9632	21.2433	1.02	A
42	337520	8/31/92	22:15:42.7	66.8857	21.7490	1.02	A
43	337588	9/1/92	22:01:15.6	66.9615	21.5207	0.93	A
44	338586	9/11/92	21:56:25.9	66.9273	20.9783	1.20	A
51	341513	10/16/92	23:09:40.6	66.9011	21.0978	1.14	A
55	343323	11/12/92	23:37:20.3	66.8911	20.9799	1.34	A
59	344466	11/24/92	23:10:41.8	66.7964	21.5019	0.90	A
8	20951	5/1/91	08:06:40.8	66.9249	21.9913	0.87	B
10	25494	6/4/91	22:12:53.2	66.9968	21.8283	0.88	B
12	28474	7/1/91	15:39:16.6	66.8572	21.8532	1.71	B
13	31064	7/19/91	14:30:25.6	66.8973	21.9321	1.56	B
18	300865	10/28/91	16:30:29.0	66.9718	21.6865	1.87	B
22	302858	12/13/91	16:31:26.8	66.8820	21.7239	1.65	B
48	340898	10/6/92	22:54:54.3	66.9608	21.2909	1.11	B
61	345683	12/16/92	23:07:31.3	66.9078	21.8386	1.23	B
5	15478	3/28/91	22:28:32.9	66.8711	21.6750	0.81	C
7	19326	4/25/91	18:23:11.6	66.9682	20.6458	-	C
45	339489	9/21/92	22:22:37.8	66.9888	21.9909	0.51	C
62	345699	12/17/92	09:53:11.8	66.9482	21.9432	0.81	C
41	337364	8/29/92	19:56:04.8	66.3954	20.7497	0.75	D
47	340339	9/28/92	17:37:30.3	66.0676	21.5750	0.64	D

Table 72: Sorted events for area 22

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
63	346759	12/30/92	12:54:14.7	66.0890	21.4066	0.71	D
3	14459	3/14/91	09:06:37.2	66.0647	21.8314	0.82	E
4	15723	3/27/91	12:14:07.1	66.0522	21.8149	0.85	E
53	342809	11/5/92	11:10:50.9	66.2882	21.1107	0.74	E
60	344658	11/30/92	11:03:00.0	66.1965	21.8287	0.66	E

Remarks:

- Events from groups A and B have a location bias with respect to the closest mines HR1 and HR3.
- Events from groups D and E define a small cluster in the South-East of Figure 23. No mine has been reported close to this cluster.

Mine and event locations:

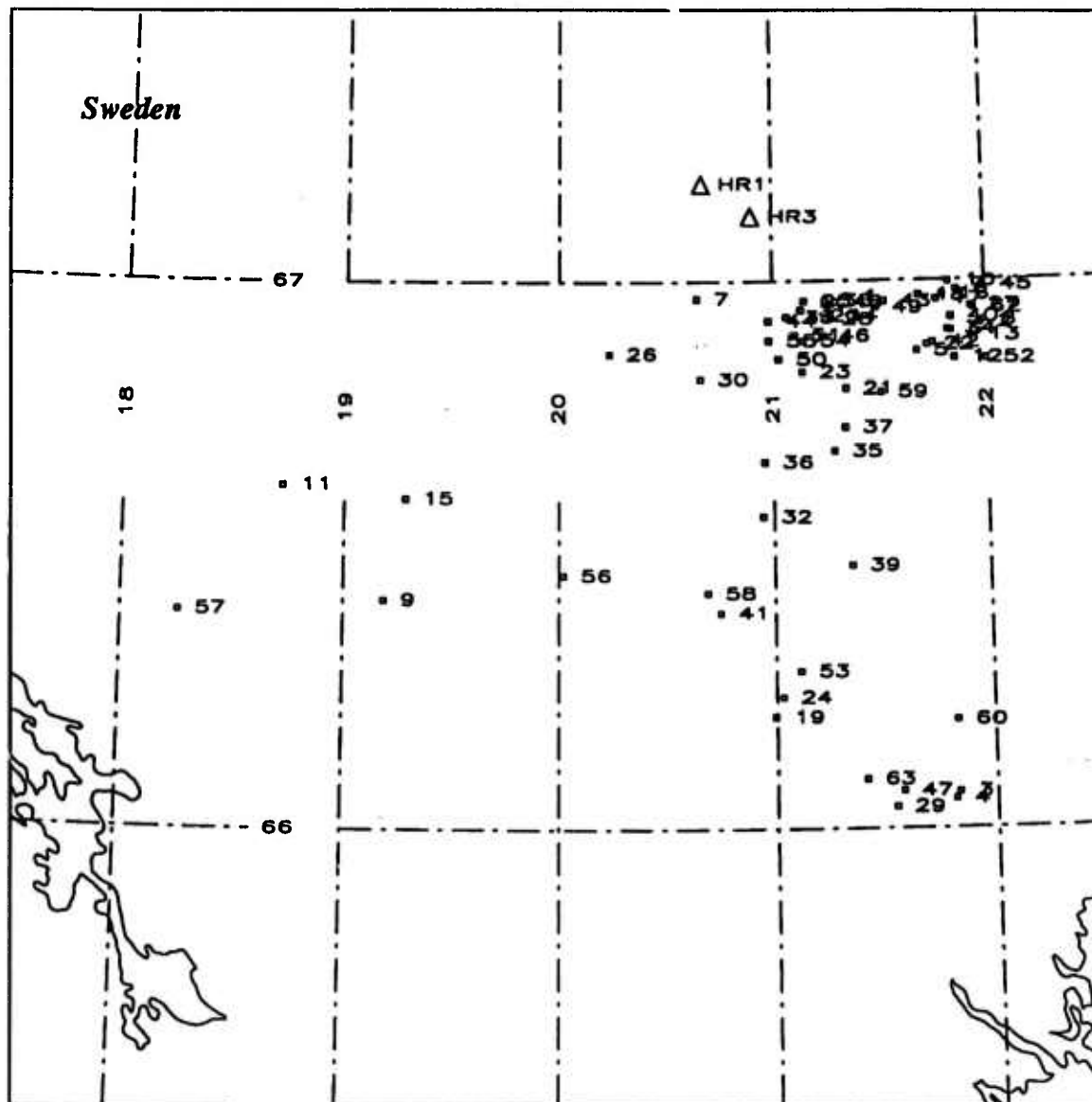


Figure 23: Mine and IMS event locations for area 22.

AREA 23

Latitude: 67 - 67.5°N

Longitude: 18 - 22°E

Local magnitude range: > 1.5

Number of events in IMS2: 968

Number of events within the magnitude range: 112

Number of processed events: 97

Frequency range used to process the data: 1 - 16 Hz

Processed signal length: 7s. before P, 62s. after P

Number of reference events:

Table 73: Reference events for area 23

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
12	12948	621440	401282	0.79	A
36	41528	951691	1259354	0.79	B
6	10111	539461	624196	0.80	C
3	3297	532961	476848	0.83	D
46	303421	1013258	1582922	0.83	E
75	334722	1370724	2423260	0.81	F
82	341042	1459160	2729862	0.79	G
95	344601	1522397	2866188	0.82	H
79	337216	1402476	2594680	0.82	I
73	332148	1324765	2228467	0.82	J

Reported mine locations:

Table 74: Mine locations for area 23

Label	Latitude °N	Longitude °E	Origin
JOG52	67.07	20.97	JOG
N212	67.0833	20.9667	NORW
HE1	67.1	20.6	old_HELS
HR3	67.12	20.90	HELS
JOG44	67.18	20.62	JOG
JOG45	67.18	20.67	JOG

Table 74: Mine locations for area 23

Label	Latitude °N	Longitude °E	Origin
HR1	67.18	20.67	HELS
JOG46	67.20	20.67	JOG
JOG47	67.20	20.71	JOG

Number of events found in the Helsinki bulletin: 59

Table 75: Events found in the Helsinki bulletin for area 23

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL label	Group
27	26031	6/11/91	15:37:02.1	1.81	HR1	EXP	-
30	30092	7/12/91	15:30:10.6	1.80	HR1	EXP	-
31	30723	7/18/91	16:14:58.0	1.59	HR1	EXP	-
32	31954	7/25/91	15:36:46.9	2.40	HR1	EXP	-
43	302274	11/25/91	17:16:33.1	2.05	HR1	EXP	-
47 ^a	312857	12/27/91	18:20:07.4	1.96	HR1	EXP	-
48 ^a	312870	1/7/92	17:14:30.8	1.79	HR1	EXP	-
49 ^a	311927	1/9/92	17:24:18.4	1.80	HR1	EXP	-
50 ^a	315270	1/20/92	16:41:12.2	1.94	HR1	EXP	-
51 ^a	313162	1/13/92	17:39:50.4	1.79	HR1	EXP	-
52 ^a	315430	1/27/92	16:29:14.3	1.62	HR1	EXP	-
54 ^a	316231	2/6/92	16:28:20.4	1.83	HR1	EXP	-
58 ^a	323558	3/27/92	16:30:05.2	2.05	HR1	EXP	-
59 ^a	325654	4/2/92	16:20:17.2	1.90	HR1	EXP	-
61 ^a	325492	4/22/92	15:30:59.9	1.80	HR1	EXP	-
66 ^a	327370	5/8/92	15:34:04.1	1.98	HR1	EXP	-
70 ^a	328736	5/22/92	14:21:19.8	2.00	HR1	EXP	-
74 ^a	333334	7/14/92	15:40:06.6	1.90	HR1	EXP	-
76 ^a	335262	8/6/92	15:42:10.8	1.78	HR1	EXP	-
55 ^a	319720	2/21/92	16:32:43.4	2.02	HR3	EXP	-
56 ^a	321675	3/12/92	16:36:53.9	1.88	HR3	EXP	-
57	322828	3/17/92	16:30:42.8	1.80	HR3	EXP	-

Table 75: Events found in the Helsinki bulletin for area 23

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL label	Group
60	326830	4/9/92	15:38:55.0	1.82	HR3		EXP	-
63 ^a	325921	4/24/92	15:55:38.8	1.92	HR3		EXP	-
67 ^a	327946	5/15/92	15:34:17.9	1.89	HR3		EXP	-
69 ^a	328219	5/18/92	15:47:06.2	1.58	HR3		EXP	-
71 ^a	330846	6/16/92	15:37:51.3	1.90	HR3		EXP	-
72 ^a	331402	6/23/92	15:36:40.8	1.91	HR3		EXP	-
77	335898	8/14/92	22:33:46.8	1.78	HR4		EXP	-
78 ^a	336485	8/20/92	15:30:33.1	1.73	67.11	20.64	-	-
12	12948	2/6/91	15:03:58.2	1.89	HE1		EXP	A
17	16859	4/5/91	16:19:04.8	1.61	HE1		EXP	A
28	27960	6/18/91	16:32:32.3	1.90	67.09	20.76	-	A
37	300111	10/1/91	16:31:02.8	1.87	HR1		EXP	A
13	15014	3/16/91	13:01:48.2	1.79	HE1		EXP	B
35	39847	9/12/91	15:33:32.0	1.65	HR1		EXP	B
38	300696	10/23/91	16:30:41.3	1.64	HR1		EXP	B
81	340394	9/29/92	16:31:32.1	1.64	HR3		EXP	B
1	5122	11/13/90	15:03:40.9	2.13	67.10	20.79	-	C
6	10111	11/30/90	18:00:07.4	2.26	HE1		EXP	C
10	314432	12/21/90	17:56:43.1	2.00	HE1		EXP	C
15	15296	3/21/91	17:09:43.0	1.76	HE1		EXP	C
16	16069	3/25/91	16:34:13.7	1.69	HE1		EXP	C
18	17092	4/6/91	07:29:38.5	1.61	HE1		EXP	C
19	17648	4/11/91	15:35:42.9	1.76	HE1		EXP	C
20	18728	4/15/91	16:39:01.0	1.88	HE1		EXP	C
24	22127	5/13/91	16:04:36.0	1.99	67.19	21.01	-	C
33	34951	8/14/91	15:38:38.9	2.13	HR1		EXP	C
34	38255	9/5/91	15:30:39.7	2.32	HR1		EXP	C
39	301290	11/1/91	17:10:02.2	1.92	HR1		EXP	C
42	301655	11/14/91	16:48:29.9	2.09	HR1		EXP	C
44	302327	12/4/91	16:39:47.1	2.02	HR1		EXP	C

Table 75: Events found in the Helsinki bulletin for area 23

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL label	Group
3	3297	11/22/90	08:53:35.7	2.08	HE1		EXP	D
9	9546	12/17/90	05:20:02.4	2.05	HE1		EXP	D
64	326877	5/4/92	01:03:03.2	1.77	HR1		EXP	D
41	301999	11/22/91	17:10:37.8	1.59	HR1		EXP	E
8	42285	12/6/90	15:03:24.8	2.02	67.08	20.90	-	F
26	24174	5/28/91	17:02:28.7	1.88	67.09	20.73		F
75	334722	7/30/92	15:31:00.4	1.73	HR1		EXP	F

a. Event with a dominant frequency content between 5 and 6 Hz.

Events with the most reliable classification:

Table 76: Sorted events for area 23

Event #	IMS orid	IMS origin time		IMS lat.	IMS lon.	IMS ml	Group
12	12948	2/6/91	15:03:58.2	67.2013	21.1681	1.89	A
17	16859	4/5/91	16:19:04.8	67.1761	21.2346	1.61	A
22	21023	5/7/91	15:58:11.1	67.1196	21.8043	1.59	A
28	27960	6/18/91	16:32:32.3	67.0126	21.5071	1.90	A
37	300111	10/1/91	16:31:02.8	67.0975	21.4396	1.87	A
13	15014	3/16/91	13:01:48.2	67.1353	21.1366	1.79	B
35	39847	9/12/91	15:33:32.0	67.0436	21.5944	1.65	B
36	41528	9/23/91	15:29:56.8	67.1108	21.0166	2.03	B
38	300696	10/23/91	16:30:41.3	67.1453	21.3004	1.64	B
81	340394	9/29/92	16:31:32.1	67.0510	21.1319	1.64	B
1	5122	11/13/90	15:03:40.9	67.1370	21.1831	2.13	C
6	10111	11/30/90	18:00:07.4	67.1515	21.4513	2.26	C
10	314432	12/21/90	17:56:43.1	67.1609	21.2964	2.00	C
11	314593	12/28/90	15:54:16.6	67.0551	21.3345	1.66	C
15	15296	3/21/91	17:09:43.0	67.1252	21.1469	1.76	C
16	16069	3/25/91	16:34:13.7	67.1675	21.3688	1.69	C
18	17092	4/6/91	07:29:38.5	67.1594	21.4736	1.61	C

Table 76: Sorted events for area 23

Event #	IMS orid	IMS origin time		IMS lat.	IMS lon.	IMS ml	Group
19	17648	4/11/91	15:35:42.9	67.1545	21.1229	1.76	C
20	18728	4/15/91	16:39:01.0	67.1039	21.4353	1.88	C
24	22127	5/13/91	16:04:36.0	67.1074	21.2971	1.99	C
25	24508	5/27/91	15:36:09.5	67.0460	21.2963	1.75	C
29	28959	7/4/91	15:37:19.7	67.0205	21.3273	1.84	C
33	34951	8/14/91	15:38:38.9	67.0643	21.4383	2.13	C
34	38255	9/5/91	15:30:39.7	67.0742	20.9543	2.32	C
39	301290	11/1/91	17:10:02.2	67.1656	21.4165	1.92	C
42	301655	11/14/91	16:48:29.9	67.1851	21.0566	2.09	C
44	302327	12/4/91	16:39:47.1	67.1391	21.2842	2.02	C
2	5131	11/13/90	22:10:04.6	67.1700	21.5070	1.59	D
3	3297	11/22/90	08:53:35.7	67.1863	21.1035	2.08	D
7	42194	12/5/90	07:11:33.4	67.2855	21.0722	2.02	D
9	9546	12/17/90	05:20:02.4	67.1949	21.0817	2.05	D
64	326877	5/4/92	01:03:03.2	67.2269	21.4048	1.77	D
41	301999	11/22/91	17:10:37.8	67.1171	21.2269	1.59	E
46	303421	12/23/91	16:30:42.7	67.1835	20.9045	1.69	E
8	42285	12/6/90	15:03:24.8	67.0755	21.3497	2.02	F
26	24174	5/28/91	17:02:28.7	67.1617	21.1678	1.88	F
75	334722	7/30/92	15:31:00.4	67.0213	21.6136	1.73	F
5	10070	11/29/90	23:33:36.6	67.4642	19.8187	1.77	G
14	15294	3/18/91	23:33:03.3	67.4974	20.0607	1.53	G
21	20207	4/26/91	22:33:47.9	67.3082	20.0564	1.58	G
40	301284	11/3/91	22:57:20.7	67.2547	20.9691	1.57	G
53	315319	1/30/92	23:13:19.2	67.2683	20.9426	1.52	G
62	325843	4/23/92	22:32:57.2	67.3639	20.1175	1.66	G
68	327967	5/15/92	22:34:52.4	67.2013	19.6238	1.76	G
82	341042	9/30/92	23:32:59.3	67.3578	19.8195	1.56	G
86	341007	10/8/92	23:36:48.3	67.2781	19.6138	1.54	G
89	342542	10/31/92	23:35:39.9	67.4308	20.0309	1.51	G

Table 76: Sorted events for area 23

Event #	IMS orid	IMS origin time		IMS lat.	IMS lon.	IMS ml	Group
96	345320	12/10/92	23:33:56.6	67.0646	19.8306	1.64	G
45	302338	12/4/91	23:34:53.1	67.1108	19.5899	1.54	H
89	338054	9/6/92	22:34:28.0	67.1917	19.3992	1.63	H
95	344601	11/28/92	23:33:49.6	67.0263	18.3746	1.56	H
79	337216	8/21/92	22:33:10.1	67.1177	19.3484	1.64	I
83	340619	10/1/92	23:35:25.7	67.1078	19.4260	1.83	I
73	332148	7/1/92	22:34:58.1	67.4800	19.9220	1.68	J
91	343474	11/10/92	23:32:20.1	67.3818	20.2628	1.51	J

Remarks:

- Twenty-six events show a monochromatic frequency content (between 5.5 and 6.0 Hz) on the ARA0/sz element. This phenomena appeared at the end of December 1991 and is affecting 50% of the events of the data set. The possibility of instrumental problems is not considered since during the same time period, recordings of events from other areas do not show this peculiar feature. In addition, the same feature can be seen on data recorded at FINESA.
- Before May 1991, the Helsinki bulletin referred to only one location in this area: 67.10°N 20.60°E
- Origin times are distributed around 15:30 and 22:30 (summer time) and 16:30 and 23:30 (winter time). The events with origin times around 22:30 (23:30 winter time) are located on the North-Western part of the map in Figure 24. They show similarities with events located at mine HR4 in area 24.

Mine and event locations:

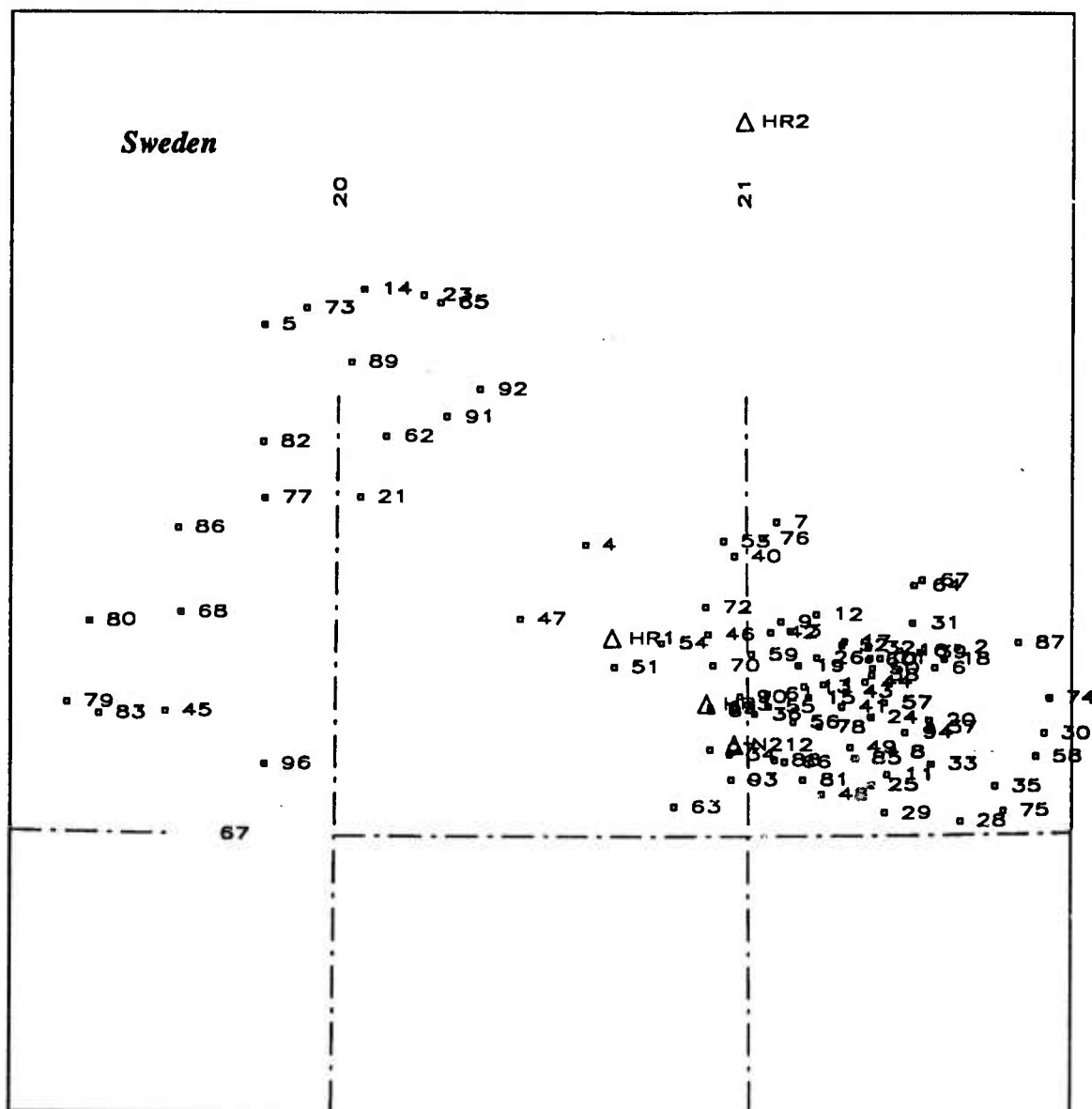


Figure 24: Mine and IMS event locations for area 23.

AREA 24

Latitude: 67.5 - 68°N

Longitude: 18 - 22°E

Local magnitude range: > 1.5

Number of events in IMS2: 2745

Number of events within the magnitude range: 109

Number of processed events: 93

Frequency range used to process the data: 2 - 16 Hz

Processed signal length: 7s. before P, 59s. after P

Number of reference events: 9

Table 77: Reference events for area 24

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
65	302661	1010830	1506163	0.83	A
51	35164	883974	1124993	0.86	B
79	328626	1276827	2051252	0.81	C
54	38417	928199	1209824	0.81	D
78	327537	1272325	2037900	0.92	E
18	19304	744641	621586	0.85	F
7	10188	612990	405572	0.83	G
81	332725	1326489	2255440	0.80	H
82	333657	1355333	2308024	0.82	I

Reported mine locations:

Table 78: Mine locations for area 24

Label	Latitude °N	Longitude °E	Origin
JOG53	67.63	21.03	JOG
HR2	67.65	21.00	HELS
HE2	67.70	21.00	old_HELS
HR4	67.80	20.20	HELS
JOG48	67.83	20.19	JOG
N211	67.833	20.205	NORW
JOG49	67.88	20.23	JOG

Number of events found in the Helsinki bulletin: 22

Table 79: Events found in the Helsinki bulletin for area 24

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
24	22732	5/14/91	22:34:27.3	1.94	67.85	20.21	-	-
26	23290	5/19/91	22:31:21.3	1.69	67.87	20.10	-	-
35	26102	6/13/91	10:48:23.2	2.49	67.83	19.62	EART	-
58	300348	10/16/91	23:35:09.8	1.68	HR4		EXP	-
61	300907	10/29/91	23:34:26.6	1.61	HR4		EXP	-
73	322810	3/22/92	23:59:55.5	1.80	HR4		EXP	-
10	14953	3/19/91	23:34:26.4	1.74	HE2		EXP	A
65	302661	12/7/91	23:35:05.9	1.83	HR4		EXP	A
14	16864	4/5/91	22:34:35.3	1.65	67.84	20.05	-	B
19	19502	4/20/91	22:31:29.5	1.52	67.88	20.1	-	B
38	28273	6/29/91	13:59:47.5	1.53	HR2		EXP	B
52	36919	8/27/91	22:34:45.0	1.64	HR4		EXP	B
43	30914	7/17/91	22:34:57.0	1.69	67.89	20.24	-	C
79	328626	5/16/92	16:40:02.3	1.62	HR4		EXP	C
86	341228	9/26/92	22:34:49.8	1.62	HR4		EXP	C
40	29123	7/5/91	22:35:41.1	1.81	HR1		EXP	D
75	326555	4/25/92	22:35:13.0	1.65	HR4		EXP	D
83	334835	7/31/92	22:35:04.4	1.65	HR4		EXP	D
85	337378	8/29/92	22:40:01.9	1.97	HR4		EXP	D
54	38417	9/6/91	22:35:08.4	1.68	67.81	20.07	-	D
15	17144	4/6/91	22:37:03.6	1.55	67.84	20.13	-	D
78	327537	5/11/92	21:44:55.2	1.56	HR1		EXP	E
4	314025	12/9/90	23:33:08.4	1.53	HE2		EXP	F

Events with the most reliable classification:

Table 80: Sorted events for area 24

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
10	14953	3/19/91	23:34:26.4	67.7215	20.8629	1.74	A
65	302661	12/7/91	23:35:05.9	67.6194	20.5122	1.83	A
68	313724	1/17/92	23:35:09.9	67.9271	20.3670	1.71	A
69	315345	1/24/92	23:35:09.0	67.8665	20.6695	1.77	A
88	343524	11/15/92	23:35:10.0	67.7671	20.9366	1.80	A
12	15763	3/27/91	23:32:56.4	67.8128	20.9172	1.60	B
13	16343	4/1/91	22:31:44.6	67.7691	20.7947	1.58	B
14	16864	4/5/91	22:34:35.3	67.8408	20.5425	1.65	B
16	17810	4/10/91	22:33:39.4	67.7635	20.9101	1.61	B
19	19502	4/20/91	22:31:29.5	67.7167	20.7320	1.52	B
21	21477	5/2/91	22:33:28.2	67.5940	21.0267	1.51	B
22	22323	5/8/91	22:31:53.2	67.8038	20.8545	1.51	B
29	24603	5/30/91	22:33:12.4	67.9581	20.1437	1.65	B
34	26041	6/11/91	22:34:29.2	67.8337	21.0477	1.55	B
38	28273	6/29/91	18:59:47.5	67.8426	21.1068	1.53	B
41	29124	7/5/91	22:38:53.2	67.9178	21.0006	1.52	B
42	30380	7/14/91	21:57:07.7	67.8210	20.6733	1.62	B
46	31272	7/22/91	22:34:35.7	67.8827	20.7466	1.59	B
47	31472	7/23/91	22:34:27.3	67.7593	20.8869	1.65	B
50	32993	7/31/91	22:35:12.4	67.8610	20.8494	1.53	B
51	35164	8/9/91	22:34:51.9	67.8940	21.0513	1.61	B
52	36919	8/27/91	22:34:45.0	67.8345	20.8000	1.64	B
53	38299	9/5/91	22:41:41.4	67.9538	21.0196	1.60	B
55	41550	9/23/91	22:34:22.8	67.8090	20.8043	1.71	B
57	300124	10/1/91	23:35:04.8	67.8721	20.5525	1.65	B
9	13374	3/6/91	23:33:13.0	67.7164	21.0720	1.51	C
23	22727	5/14/91	20:20:49.7	67.8641	20.9334	1.53	C
43	30914	7/17/91	22:34:57.0	67.7169	20.8458	1.69	C

Table 80: Sorted events for area 24

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
70	317866	2/20/92	23:33:45.2	67.8168	20.8601	1.54	C
79	328626	5/16/92	16:40:02.3	67.7991	20.7965	1.62	C
80	331341	6/22/92	22:34:19.5	67.5148	20.2071	1.63	C
86	340228	9/26/92	22:34:49.8	67.8152	21.2550	1.62	C
87	340756	9/30/92	11:13:37.7	67.8152	21.3061	1.51	C
15	17144	4/6/91	22:37:03.6	67.7996	20.9129	1.55	D
25	23177	5/17/91	22:36:04.4	67.7840	20.7139	1.52	D
40	29123	7/5/91	22:35:41.1	67.7648	20.8015	1.81	D
54	38417	9/6/91	22:35:08.4	67.8012	20.8167	1.68	D
63	302006	11/22/91	23:34:06.9	67.8130	20.6215	1.80	D
67	313029	1/11/92	10:13:21.0	67.7717	20.9770	1.59	D
75	326555	4/25/92	22:35:13.0	67.8847	20.9680	1.65	D
83	334835	7/31/92	22:35:04.4	67.7024	21.1369	1.65	D
85	337378	8/29/92	22:40:01.9	67.8586	20.6815	1.97	D
78	327537	5/11/92	21:44:55.2	67.8317	21.1613	1.56	E
91	344626	11/29/92	12:57:06.5	67.7547	20.8902	1.77	E
4	314025	12/9/90	23:33:08.4	67.7846	20.6952	1.53	F
17	18736	4/15/91	22:33:19.2	67.7536	21.1406	1.53	F
18	19304	4/19/91	22:33:12.5	67.7475	20.8005	1.52	F
7	10188	2/1/91	23:36:54.1	67.8174	20.9144	1.59	G
60	300840	10/26/91	23:35:03.9	67.8230	20.7486	1.64	G
5	7823	1/15/91	23:34:02.6	67.7398	21.0070	1.56	H
36	27713	6/17/91	22:35:02.8	67.5106	19.9350	1.54	H
71	319324	2/24/92	23:35:11.3	67.6676	20.0633	1.69	H
81	332725	7/8/92	22:33:58.2	67.5550	20.4177	1.54	H
84	336524	8/20/92	22:34:31.6	67.5087	20.1936	1.67	H
89	343911	11/20/92	23:34:18.4	67.5551	20.2763	1.57	H
82	333657	7/17/92	22:33:40.8	67.7703	21.0439	1.53	I
92	344755	12/1/92	23:32:44.8	67.5738	19.8286	1.55	I

Remarks:

- The vast majority of these events have their origin time around 22:35 (summer time) and 23:35 (winter time) which are characteristic shooting times of the Kiruna mine (HR4) located in this area.
- The large number of events needed to represent all kind of signals coming from this mine may be explained by the size of the mine (4 km long North-South) and the different depths of the shots.
- A location bias is seen on Figure 25 which has been studied by Henson *et al.* (1992).

Mine and event locations:

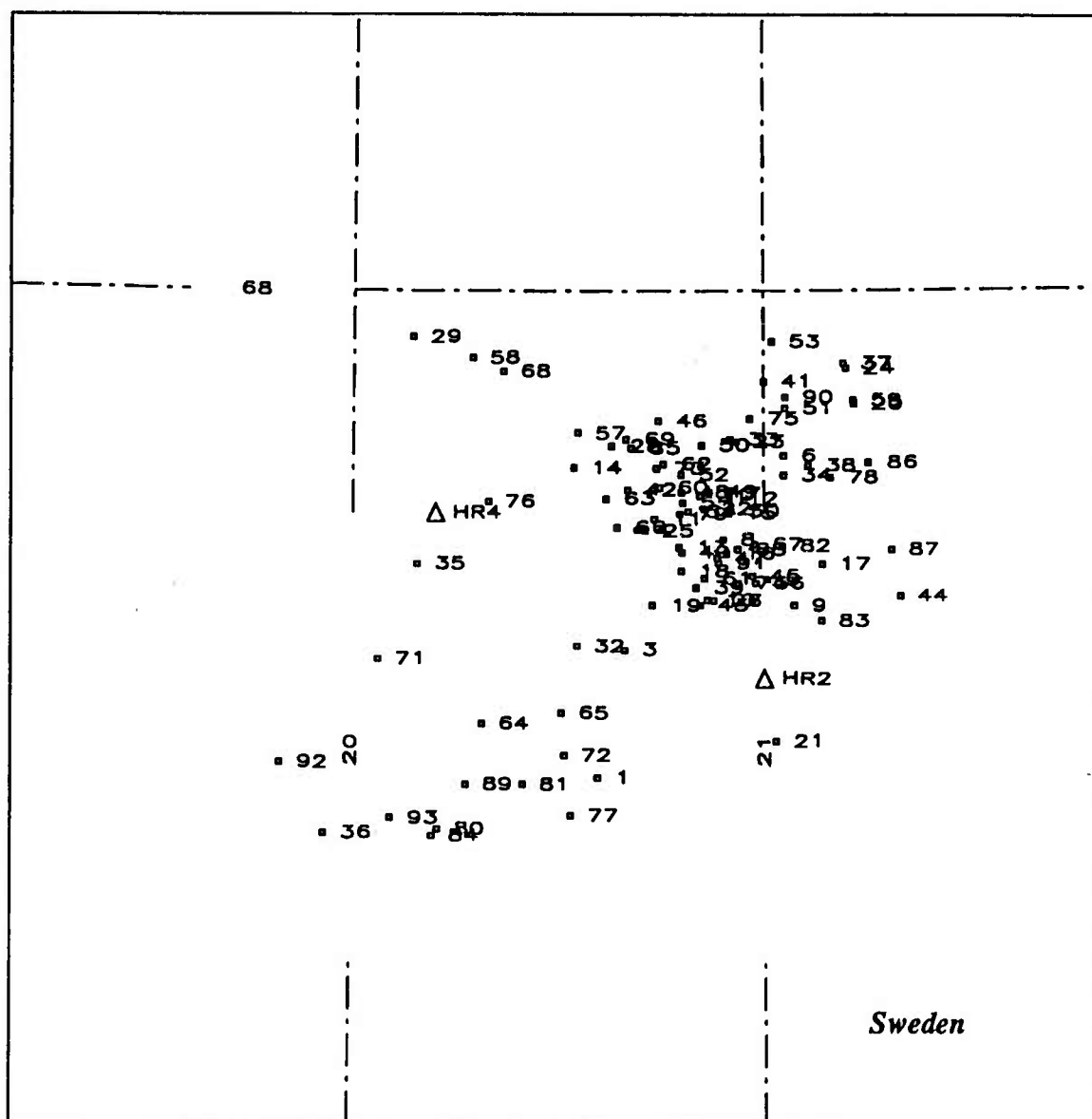


Figure 25: Mine and IMS event locations for area 24.

AREA 25

Latitude: 66 - 68 °N

Longitude: 12 - 18 °E

Local magnitude range: -

Number of events in IMS2: 146

Number of events within the magnitude range: 146

Number of processed events: 120

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 11 s. before P, 101 s. after P

Number of reference events: 7

Table 81: Reference events for area 25

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
99	339193	1438945	2689497	0.79	A
61	320060	1194544	1742133	0.80	B
69	326980	1238647	2017326	0.80	C
34	303251	1013585	1608061	0.87	D
53	313091	1163425	1656897	0.85	E
83	331416	1292513	2188588	0.75	F
45	312925	1031109	1608139	0.78	G

Reported mine locations:

Table 82: Mine locations for area 25

Label	Latitude °N	Longitude °E	Origin
N213	66.13329	17.18330	NORW
N3	66.42	14.68	NORW
N5	67.15	16.07	NORW

Number of events found in the Helsinki bulletin or in the Bergen bulletin: 46

Table 83: Events reported in the Helsinki bulletin or in the Bergen bulletin for area 25

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	BER orid	Group
73	328535	05/18/92	13:47:02	2.74	66.91	13.63	EART		-
90	335878	08/01/92	11:16:02	2.69	66.41	13.21	EART		-
28	300855	10/28/91	12:57:46.3	2.24	66.40	14.37	-		A
99	339193	9/17/92	11:59:58.2	-	66.50	14.76	-		A
18	29706	7/11/91	08:11:49.4	1.98	66.43	14.67	-		B
61	320060	2/25/92	22:08:56.3	-	67.48	14.75	P.E.		B
69	326980	5/5/92	08:00:23.5	2.10	66.45	14.71	-		C
75	328647	5/21/92	20:09:56.6	-	66.43	14.77	-		C
85	333009	6/27/92	13:49:06.8	1.79	66.83	13.59	-		C
34	303251	1/1/92	08:39:04.2	2.01	67.77	15.17	EART	3 ^a	D
46	313181	1/10/92	22:25:42.3	2.06	67.72	14.97	EART	32 ^a	D
47	313020	01/11/92	01:45:35	1.49	-	-	-	51 ^a	D
50	313018	01/11/92	01:17:30	1.50	-	-	-	50 ^a	D
110	343515	11/15/92	18:30:36.0	-	-	-	-	^a	D
111	343517	11/15/92	18:44:46.5	-	-	-	-	^a	D
112	343518	11/15/92	18:58:44.4	-	-	-	-	^a	D
14	26883	6/15/91	02:52:39.5	1.53	67.73	15.15	P.E.	-	E
35	303471	01/04/92	03:43:44	1.93	-	-	-	35 ^a	E
42	303433	1/5/92	05:11:56.1	1.64	67.76	15.16	P.E.	18 ^a	E
53	313091	1/25/92	11:57:35.3	1.91	67.56	15.40	P.E.	56 ^a	E
54	313094	1/25/92	12:16:46.2	2.71	67.75	15.09	EART	57 ^a	E
58	315678	02/03/92	23:39:09	1.55	-	-	-	63 ^b	E
114	343513	11/16/92	01:30:19.6	-	-	-	-	^a	E
116	344386	11/20/92	18:49:28.0	1.15	-	-	-	^a	E
38	312938	1/4/92	06:00:51.7	-	67.77	15.24	EART	12 ^a	F
39	303256	1/4/92	09:06:29.3	2.22	67.78	15.22	EART	13 ^a	F
40	303395	1/5/92	01:20:49.5	1.71	67.71	15.17	P.E.	16 ^a	F
55	313112	1/25/92	19:12:53.7	1.83	67.57	15.42	P.E.	59 ^b	F

Table 83: Events reported in the Helsinki bulletin or in the Bergen bulletin for area 25

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	BER orid	Group
64	321224	2/29/92	20:47:11.6	2.08	67.48	14.75	P.E.	^a	F
76	328628	5/19/92	08:30:22.6	-	-	-	-	^a	F
80	330639	6/12/92	04:48:37.7	2.13	67.68	15.05	P.E.	^a	F
82	331414	6/20/92	21:37:17.9	2.29	67.78	15.19	P.E.	^a	F
83	331416	6/20/92	23:01:31.6	2.74	67.79	15.21	P.E.	^a	F
36	312934	1/4/92	04:15:04.7	-	67.78	15.13	EART	10 ^a	G
37	303473	01/04/92	05:33:24	1.05	-	-	-	37 ^a	G
41	303428	01/05/92	02:31:20	1.16	-	-	-	41 ^a	G
44	303493	01/06/92	08:26:23	1.58	-	-	-	46 ^a	G
45	312925	1/1/92	10:15:08.4	1.79	67.74	15.19	P.E.	4 ^a	G
49	312926	01/01/92	14:46:11	1.36	-	-	-	34 ^b	G
52	312922	01/01/92	08:57:09	-	-	-	-	32 ^b	G
57	315636	02/03/92	04:15:43	1.13	-	-	-	63 ^a	G
115	343800	11/17/92	13:02:24.7	1.41	-	-	-	^a	G
73	328535	5/18/92	13:47:01.8	2.74	66.91	13.63	EART	-	^c
43	303125	1/5/92	07:57:10.3	1.00	-	-	-	44	^d
51	312921	1/1/92	08:18:07.9	-	-	-	-	29	^d
90	335878	8/3/92	11:16:01.5	2.69	66.41	13.21	EART	-	^d

a. Confirmed by K. Atakan.

b. Event provided by T. Sereno, not confirmed by K. Atakan.

c. Overlapping events.

d. Event not sorted.

Events with the most reliable classification:

Table 84: Sorted events for area 25

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
1	7524	11/21/90	12:40:37.2	66.3572	15.1024	2.05	A
2	10134	12/17/90	09:58:58.1	66.3395	15.2338	1.75	A
28	300855	10/28/91	12:57:46.3	66.3166	15.1514	2.24	A
31	302796	12/6/91	12:37:01.2	66.4437	14.9816	2.21	A
60	317832	2/20/92	12:54:24.0	66.2465	15.1126	1.30	A

Table 84: Sorted events for area 25

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
66	323134	3/31/92	06:39:04.1	66.2011	15.8001	1.43	A
67	325157	4/1/92	23:31:07.2	66.5548	14.9065	1.59	A
92	336714	8/13/92	13:26:07.9	66.0697	16.2137	1.57	A
99	339193	9/17/92	11:59:58.2	66.4837	14.6998	-	A
117	344459	11/25/92	10:29:46.7	66.4714	14.8406	1.94	A
18	29706	7/11/91	08:11:49.4	66.1959	16.0441	1.98	B
27	41639	9/25/91	11:50:52.9	66.4171	14.9897	2.15	B
61	320060	2/25/92	22:08:56.3	66.7613	14.0294	-	B
63	320293	2/26/92	11:31:27.9	66.4696	15.0185	1.54	B
72	327483	5/6/92	19:18:34.1	66.3405	14.9448	1.54	B
89	333207	7/13/92	00:48:12.6	66.8199	13.8241	1.33	B
98	338208	9/8/92	04:15:57.1	66.7930	13.6135	1.69	B
107	342368	10/27/92	14:57:54.8	66.8163	13.6956	2.06	B
118	345519	12/9/92	15:51:17.1	66.2027	16.2242	1.43	B
119	346212	12/15/92	00:26:28.7	66.3860	14.8608	1.30	B
33	302995	12/18/91	16:31:57.1	66.4057	14.9794	2.01	C
69	326980	5/5/92	08:00:23.5	66.0903	16.7915	2.10	C
75	328647	5/21/92	20:09:56.6	66.4179	15.1123	-	C
79	330532	5/30/92	05:51:38.2	66.8275	13.4079	1.93	C
85	333009	6/27/92	13:49:06.8	66.7363	13.9748	1.79	C
87	333188	7/10/92	09:19:02.5	66.3592	15.3888	2.01	C
101	340744	10/1/92	17:47:48.0	66.7401	14.2977	1.79	C
34	303251	1/1/92	08:39:04.2	67.5156	15.8723	2.01	D
46	313181	1/10/92	22:25:42.3	67.6260	15.4633	2.06	D
47	313020	1/11/92	01:45:34.9	67.0719	16.0868	1.49	D
50	313018	1/11/92	01:17:29.6	67.0333	16.2929	1.50	D
110	343515	11/15/92	18:30:36.0	66.7549	16.9413	-	D
111	343517	11/15/92	18:44:46.5	66.8215	17.1151	-	D
112	343518	11/15/92	18:58:44.4	67.3430	16.3643	-	D
14	26883	6/15/91	02:52:39.5	67.5410	15.6738	1.53	E

Table 84: Sorted events for area 25

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
15	28221	7/3/91	05:11:09.4	67.5759	16.9945	1.29	E
24	35805	8/21/91	01:28:03.8	66.7605	16.5446	1.34	E
35	303471	1/4/92	03:43:44.1	67.4594	15.6312	1.93	E
42	303433	1/5/92	05:11:56.1	67.5708	15.4463	1.64	E
53	313091	1/25/92	11:57:35.3	67.6413	15.5252	1.91	E
54	313094	1/25/92	12:16:46.2	67.6892	15.3479	2.71	E
58	315678	2/3/92	23:39:09.2	67.1794	16.6321	1.55	E
114	343513	11/16/92	01:30:19.6	67.7129	15.2284	-	E
116	344386	11/20/92	18:49:28.0	66.9233	16.4507	1.15	E
38	312938	1/4/92	06:00:51.7	67.8151	15.0871	-	F
39	303256	1/4/92	09:06:29.3	67.6646	15.2246	2.22	F
40	303395	1/5/92	01:20:49.5	67.3244	16.1006	1.71	F
55	313112	1/25/92	19:12:53.7	67.5236	15.8805	1.83	F
64	321224	2/29/92	20:47:11.6	67.5982	15.5651	2.08	F
76	328628	5/19/92	08:30:22.6	67.5139	15.7613	-	F
80	330639	6/12/92	04:48:37.7	67.6789	15.3625	2.13	F
82	331414	6/20/92	21:37:17.9	67.3420	16.4282	2.29	F
83	331416	6/20/92	23:01:31.6	67.5604	15.6845	2.74	F
108	342557	10/30/92	19:34:15.8	67.1415	16.1542	1.39	F
36	312934	1/4/92	04:15:04.7	67.5847	15.4876	-	G
37	303473	1/4/92	05:33:23.6	66.8573	16.4742	1.05	G
41	303428	1/5/92	02:31:19.5	67.6014	17.1640	1.16	G
44	303493	1/6/92	08:26:23.4	67.1629	16.4434	1.58	G
45	312925	1/1/92	10:15:08.4	67.0345	16.0389	1.79	G
49	312926	1/1/92	14:46:10.7	66.9356	16.7003	1.36	G
52	312922	1/1/92	08:57:09.2	67.4827	16.0597	-	G
57	315636	2/3/92	04:15:42.6	67.2326	16.0450	1.13	G
115	343800	11/17/92	13:02:24.7	66.8555	17.1680	1.41	G

Remarks:

- Events from groups D, E, F and G are part of the earthquake swarm that occurred in Steigen (Norway) in 1992 (Atakan, 1992).
- According to the author, the activity started on January 1, 1992. The event classification revealed that three events of the studied data set were very similar to the events from the swarm. They occurred in the same area in June 1991, July 1991 and August 1991, respectively.
- The list of Steigen events provided by the University of Bergen and shown in Table 83 does not include all events associated with this swarm of earthquakes. Only 25 events (23 are shown in Table 83) were on this list while the author reported 89 events between January 1, 1992 and February 18, 1992.

Mine and event locations:

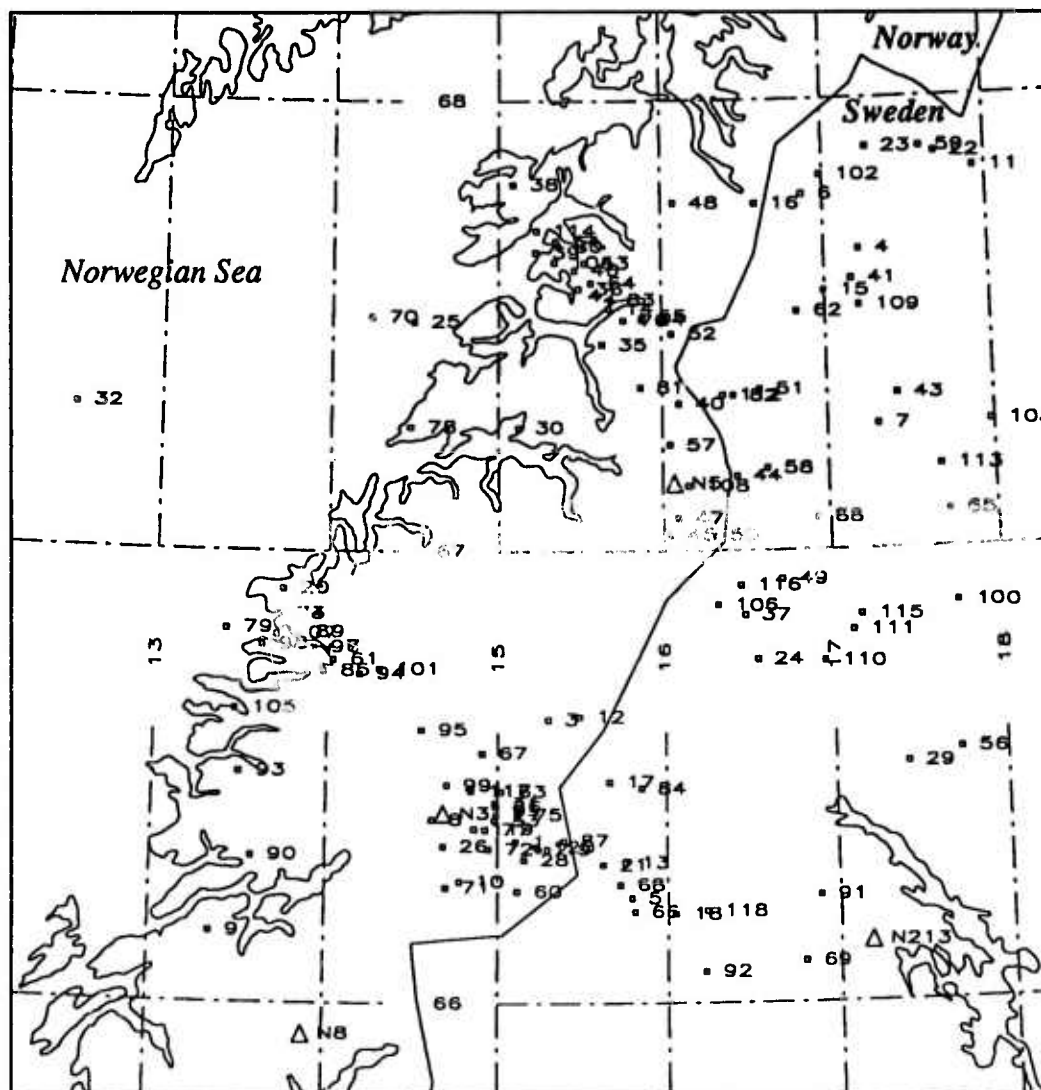


Figure 26: Mine and IMS event locations for area 25.

AREA 26

Latitude: 64 - 66°N

Longitude: 10 - 18°E

Local magnitude range: -

Number of events in IMS2: 27

Number of events within the magnitude range: 27

Number of processed events: 17

Number of events found in the Helsinki bulletin: None

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 11s. before P, 101s. after P

Number of reference events: None

Reported mine locations:

Table 85: Mine locations for area 26

Label	Latitude °N	Longitude °E	Origin
N216	64.10	12.5833	NORW
N9	64.07	11.20	NORW
N7	64.87	13.88	NORW
N8	65.93	13.88	NORW

Remarks:

- Only a small number of events are located in this area and they all look different.
- The IMS locations do not show any tendency to cluster on Figure 27. They probably have diverse sources.

Events with the most reliable classification: None

Mine and event locations:

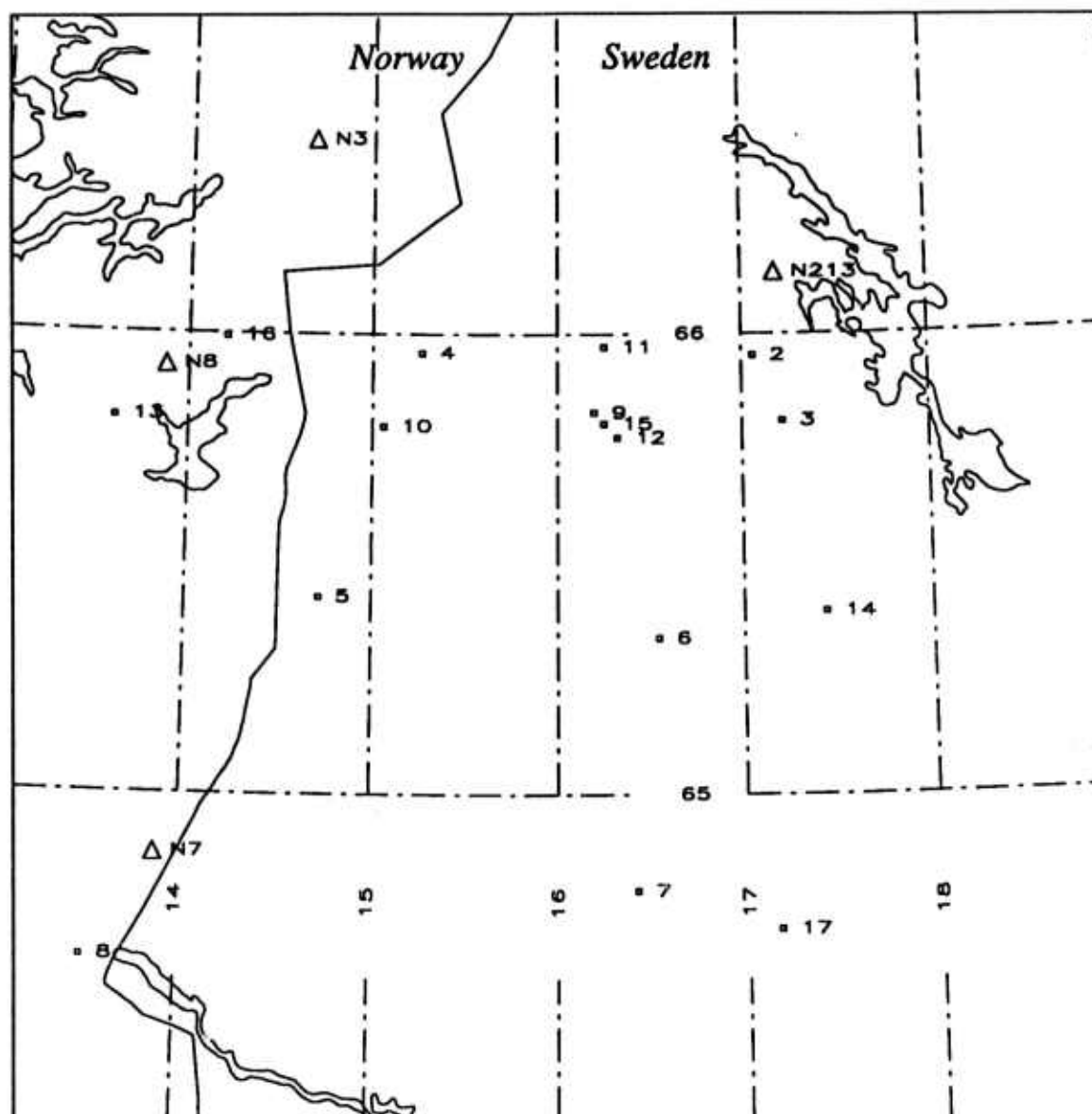


Figure 27: Mine and IMS event locations for area 26.

AREA 27

Latitude: 64 - 66°N

Longitude: 18 - 24°E

Local magnitude range: -

Number of events in IMS2: 54

Number of events within the magnitude range: 54

Number of processed events: 38

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 11s. before P, 101s. after P

Number of reference events: None

Reported mine locations:

Table 86: Reported mine locations for area 27

Label	Latitude °N	Longitude °E	Origin
N220	64.05000	20.71670	NORW
N216	64.10000	19.58330	NORW
N214	64.13329	18.56670	NORW

Number of events found in the Helsinki bulletin: 13

Table 87: Events found in the Helsinki bulletin for area 27

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
4	11179	1/19/91	21:01:13.8	2.28	65.66	18.06	P.E.	-
9	25522	6/5/91	09:05:53.0	1.71	64.32	20.77	P.E.	-
10	25748	6/6/91	12:46:11.5	3.22	65.58	22.70	P.E.	-
12	32436	7/28/91	20:38:51.6	1.09	65.78	22.57	P.E.	-
15	41532	9/23/91	19:20:28.3	3.15	64.58	21.40	EART	-
16	41547	9/23/91	20:53:26.2	1.29	64.44	21.31	P.E.	-
17	301196	11/8/91	22:07:51.4	1.98	65.23	22.71	P.E.	-
23	325621	4/2/92	12:40:05.1	1.68	64.01	23.55	-	-
27	327190	4/16/92	10:21:42.6	2.34	64.18	20.64	EART	-
32	336422	8/11/92	20:43:20.5	2.06	64.47	20.95	P.E.	-
33	337513	8/31/92	18:57:38.3	1.05	HM22		EXP	-

Table 87: Events found in the Helsinki bulletin for area 27

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
34	338193	9/4/92	21:58:07.5	1.46	65.89	22.00	P.E.	-
35	340554	9/28/92	14:48:53.5	1.42	65.01	21.34	P.E.	-

Remarks:

- Only two events are really similar: events 15 and 16 that occurred in the Bothnian Bay, on the same day.
- The other events look different from each other and their spread locations reflects their diverse origin.

Mine and event locations:

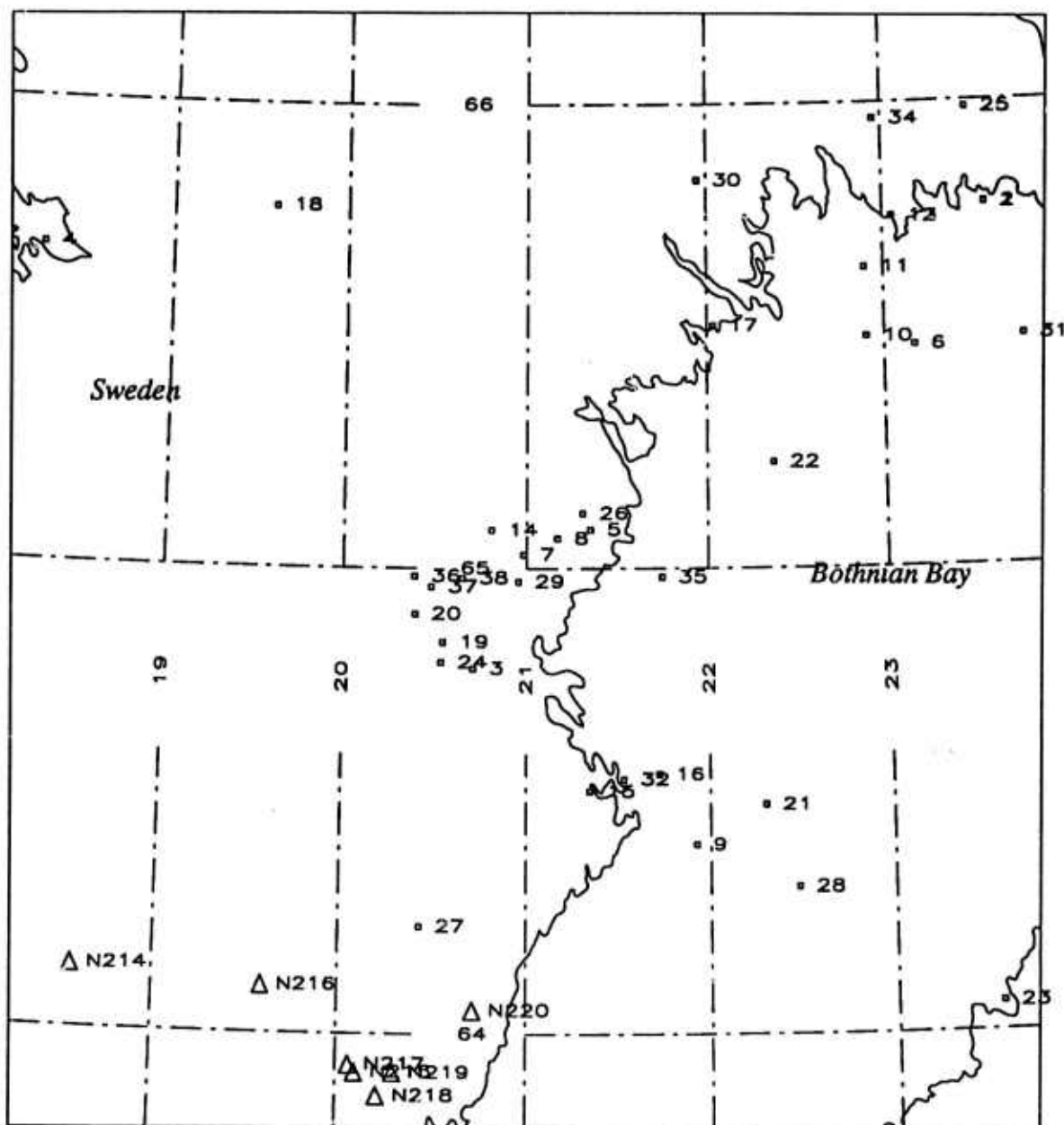


Figure 28: Mine and IMS event locations for area 27.

AREA 28

Latitude: 64 - 66°N

Longitude: 24 - 26°E

Local magnitude range: -

Number of events in IMS2: 108

Number of events within the magnitude range: 108

Number of processed events: 83

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 11s. before P, 101s. after P

Number of reference events: 7

Table 88: Reference events for area 28

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
11	16856	727625	555043	0.84	A
75	341881	1481791	2776002	0.84	B
19	22198	782964	746397	0.83	C
78	344303	1505955	2858163	0.85	D
42	301329	1004387	1439950	0.80	E
17	21747	763641	756882	0.83	F
50	321822	1225658	1831221	0.81	G

Reported mine locations:

Table 89: Mine locations for area 28

Label	Latitude °N	Longitude °E	Origin
HM9	64.1	24.7	HELS
HM11	64.41	25.15	HELS
N106	64.41	25.15	NORW
HM22	65.78	24.70	HELS
N107	65.78	24.70	NORW
HA25	65.8	24.7	old_HELS
N120	65.90	24.47	NORW

Number of events found in the Helsinki bulletin: 55

Table 90: Events found in the Helsinki bulletin for area 28

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
1	3005	11/21/90	14:17:56.5	1.40	65.15	25.69	-	-
6	322356	2/4/91	12:27:38.1	1.31	65.16	25.47	-	-
10	15958	3/28/91	08:28:16.8	1.32	64.42	24.10	-	-
14	19218	4/19/91	07:31:52.0	1.26	65.08	25.56	-	-
16	21337	5/2/91	12:54:52.8	1.20	64.18	24.02	-	-
33	36903	8/27/91	12:25:49.9	1.28	65.09	25.59	-	-
37	40215	9/18/91	09:47:49.4	1.30	65.10	25.65	-	-
38	40608	9/20/91	08:35:16.1	1.24	65.09	25.58	-	-
48	320994	2/28/92	13:41:53.4	1.07	64.26	24.31	-	-
55	325707	4/3/92	07:45:42.1	1.40	65.11	25.59	-	-
67	335816	8/14/92	07:57:43.1	1.29	65.10	25.65	-	-
68	337507	8/31/92	16:13:57.4	1.08	64.66	24.36	-	-
71	340308	9/28/92	13:07:09.2	1.60	65.10	25.64	-	-
26	25918	6/11/91	19:00:37.0	1.31	HM22		EXP	-
35	38405	9/6/91	17:04:50.7	1.78	HM22		EXP	-
49	324243	3/19/92	12:56:32.0	1.59	HM22		EXP	-
52	323572	3/31/92	19:32:29.6	1.08	HM22		EXP	-
62	330907	6/17/92	10:59:58.6	1.75	HM22		EXP	-
64	332806	7/9/92	15:37:07.2	1.19	HM22		EXP	-
65	333488	7/16/92	09:01:58.5	1.43	HM22		EXP	-
4	8870	1/24/91	20:03:51.3	1.70	HA25		EXP	A
11	16856	4/5/91	14:52:34.4	1.62	HA25		EXP	A
12	17653	4/11/91	17:10:11.2	1.52	HA25		EXP	A
56	326832	4/9/92	17:09:22.3	1.53	HM22		EXP	A
69	339009	9/10/92	17:09:37.4	1.74	HM22		EXP	A
41	41890	9/27/91	17:16:15.1	1.35	HM22		EXP	B
53	323575	3/31/92	20:05:10.1	1.66	HM22		EXP	B
61	329115	5/27/92	10:58:41.6	1.79	HM22		EXP	B

Table 90: Events found in the Helsinki bulletin for area 28

Event #	IMS orid	IMS origin time		IMS ml	HEL location	HEL lab	Group
15	19295	4/19/91	17:01:54.3	1.84	HA25	EXP	C
19	22198	5/13/91	18:50:07.6	1.61	HA25	EXP	C
25	25900	6/7/91	18:56:11.8	2.00	HM22	EXP	C
13	18124	4/17/91	19:24:46.5	1.65	HA25	EXP	D
23	24175	5/28/91	17:06:19.4	1.69	HA25	EXP	D
24	24589	5/30/91	17:00:25.4	1.81	HA25	EXP	D
34	36911	8/27/91	17:01:44.4	1.36	HM22	EXP	D
70	339136	9/17/92	17:08:41.4	-999.00	HM22	EXP	D
30	34956	8/14/91	17:00:29.7	1.82	HM22	EXP	E
31	35825	8/21/91	10:59:43.5	1.06	HM22	EXP	E
39	40685	9/20/91	14:53:29.1	1.29	HM22	EXP	E
40	41703	9/26/91	10:59:59.0	2.00	HM22	EXP	E
42	301329	11/4/91	12:15:35.7	1.68	HM22	EXP	E
44	312860	1/7/92	12:03:41.5	1.09	HM22	EXP	E
2	8324	11/26/90	19:57:27.3	1.56	HA25	EXP	F
3	7627	1/15/91	11:55:08.2	1.92	HA25	EXP	F
7	13531	3/7/91	19:48:41.5	1.45	HA25	EXP	F
8	14943	3/19/91	19:51:35.2	1.48	HA25	EXP	F
9	15755	3/27/91	18:05:49.9	1.54	HA25	EXP	F
17	21747	5/3/91	17:03:59.7	1.70	HA25	EXP	F
20	22654	5/17/91	15:00:05.1	1.14	HA25	EXP	F
29	34336	8/13/91	17:05:43.8	1.54	HM22	EXP	F
43	301251	11/12/91	15:57:54.4	1.45	HM22	EXP	G
45	321011	2/28/92	16:14:35.0	1.53	HM22	EXP	G
46	321744	3/6/92	18:14:47.6	1.47	HM22	EXP	G
50	321822	3/20/92	18:19:46.3	1.70	HM22	EXP	G
57	324967	4/15/92	18:58:55.0	1.31	HM22	EXP	G

Events with the most reliable classification:

Table 91: Sorted events for area 28

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
4	8870	1/24/91	20:03:51.3	65.8656	24.9151	1.70	A
11	16856	4/5/91	14:52:34.4	65.7620	24.6712	1.62	A
12	17653	4/11/91	17:10:11.2	65.8296	24.2717	1.52	A
56	326832	4/9/92	17:09:22.3	65.7227	25.0668	1.53	A
69	339009	9/10/92	17:09:37.4	65.7954	24.9621	1.74	A
41	41890	9/27/91	17:16:15.1	65.6729	24.7773	1.35	B
53	323575	3/31/92	20:05:10.1	65.8121	25.1158	1.66	B
61	329115	5/27/92	10:58:41.6	65.5559	25.0345	1.79	B
72	340925	10/7/92	11:59:56.9	65.7325	25.0824	1.72	B
73	341278	10/13/92	16:02:18.7	65.8776	25.0708	1.49	B
75	341881	10/21/92	11:54:29.8	65.8524	24.9587	1.58	B
15	19295	4/19/91	17:01:54.3	65.7607	25.1053	1.84	C
19	22198	5/13/91	18:50:07.6	65.8084	25.0236	1.61	C
25	25900	6/7/91	18:56:11.8	65.7913	25.0167	2.00	C
59	327686	5/13/92	17:10:05.7	65.8478	24.7954	-999.00	C
76	343317	11/12/92	19:51:15.9	65.8793	24.3314	1.49	C
13	18124	4/17/91	19:24:46.5	65.7533	25.9013	1.65	D
23	24175	5/28/91	17:06:19.4	65.8349	25.0865	1.69	D
24	24589	5/30/91	17:00:25.4	65.8514	25.3562	1.81	D
34	36911	8/27/91	17:01:44.4	65.7524	24.9877	1.36	D
70	339136	9/17/92	17:08:41.4	65.8272	25.0053	-	D
78	344303	11/25/92	15:59:53.0	65.8583	25.1809	1.70	D
21	24022	5/23/91	17:03:15.1	65.8041	24.9901	1.30	E
30	34956	8/14/91	17:00:29.7	65.5767	25.4875	1.82	E
31	35825	8/21/91	10:59:43.5	65.7527	25.7084	1.06	E
39	40685	9/20/91	14:53:29.1	65.6215	25.0284	1.29	E
40	41703	9/26/91	10:59:59.0	65.8481	25.2756	2.00	E
42	301329	11/4/91	12:15:35.7	65.8468	25.6021	1.68	E

Table 91: Sorted events for area 28

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
44	312860	1/7/92	12:03:41.5	65.5997	25.0222	1.09	E
2	8324	11/26/90	19:57:27.3	65.8014	25.2255	1.56	F
3	7627	1/15/91	11:55:08.2	65.8070	25.1888	1.92	F
7	13531	3/7/91	19:48:41.5	65.7870	25.4191	1.45	F
8	14943	3/19/91	19:51:35.2	65.8721	25.1724	1.48	F
9	15755	3/27/91	18:05:49.9	65.8579	25.0173	1.54	F
17	21747	5/3/91	17:03:59.7	65.7756	25.2348	1.70	F
20	22654	5/17/91	15:00:05.1	65.9917	25.3301	1.14	F
29	34336	8/13/91	17:05:43.8	65.7984	24.2873	1.54	F
43	301251	11/12/91	15:57:54.4	65.8152	24.8128	1.45	G
45	321011	2/28/92	16:14:35.0	65.8056	24.8523	1.53	G
46	321744	3/6/92	18:14:47.6	65.8021	24.8924	1.47	G
50	321822	3/20/92	18:19:46.3	65.7922	24.3537	1.70	G
57	324967	4/15/92	18:58:55.0	65.8311	24.7173	1.31	G
60	328439	5/20/92	15:06:01.3	65.7000	25.0149	1.38	G
83	347185	1/5/93	17:53:25.6	65.9859	24.4278	1.64	G

Remarks:

- According to the Helsinki bulletin identification, all events in group A, B, C, D, E, F and G originate from the same mine HM22 (HA25).
- The unsorted events have locations spread over the area. Most of them have low signal-to-noise ratio or are mixed with another event.

Mine and event locations:

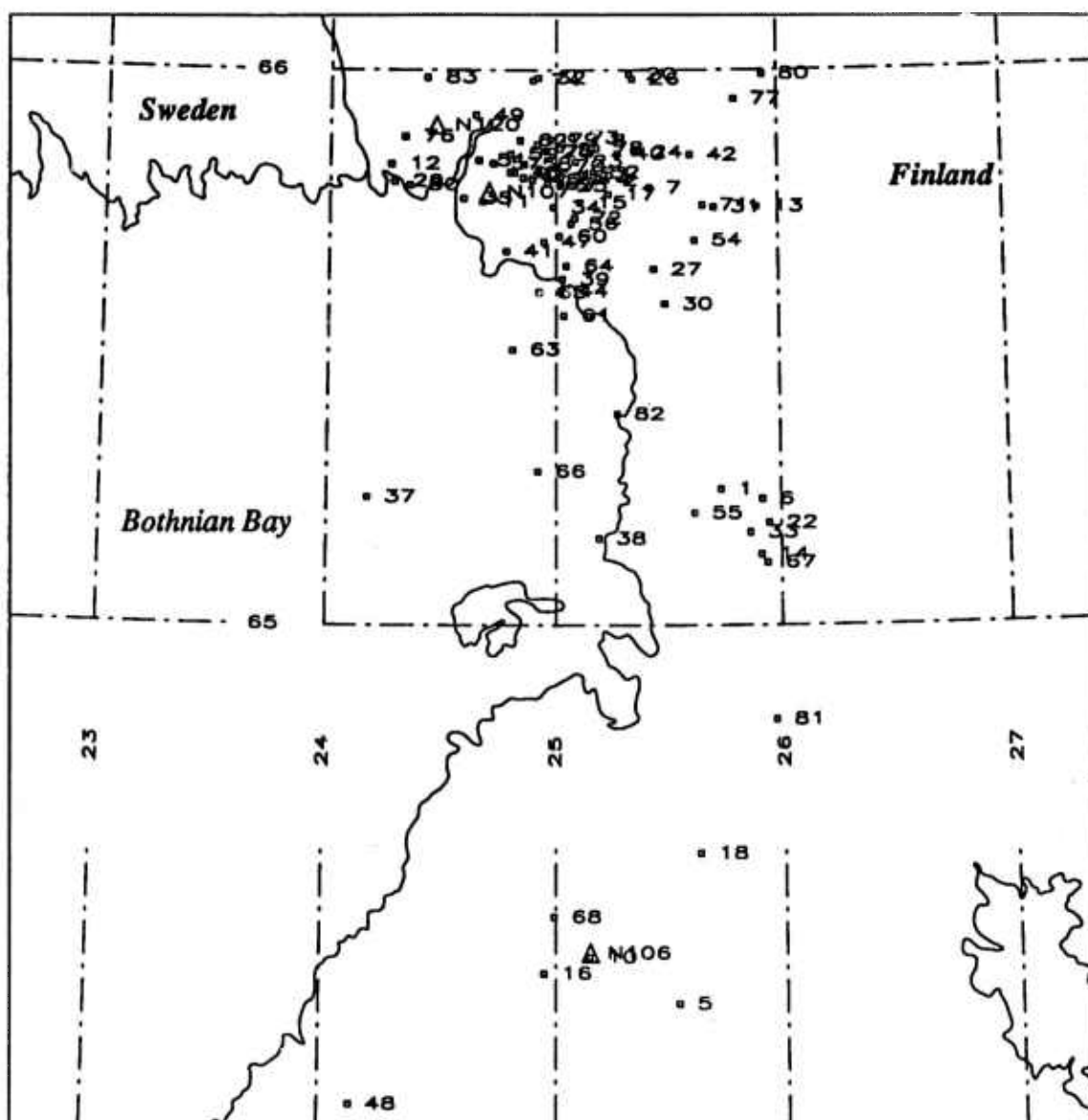


Figure 29: Mine and IMS event locations for area 28.

AREA 29

Latitude: 64 - 66°N

Longitude: 26 - 30°E

Local magnitude range: -

Number of events in IMS2: 62

Number of events within the magnitude range: 62

Number of processed events: 44

Frequency range used to process the data: 5 - 16 Hz

Processed signal length: 10s. before P, 90s. after P

Number of reference events: 6

Table 92: Reference events for area 29

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
26	302298	1009376	1496989	0.90	A
5	14119	703299	475477	0.84	B
33	326412	1237387	2001654	0.81	C
16	22125	781981	744570	0.77	D
1	5806	526393	629008	0.86	E
18	23030	787126	784740	0.81	F

Reported mine locations:

Table 93: Mine locations for area 29

Label	Latitude °N	Longitude °E	Origin
HM10	64.1	27.1	HELS
HM8	64.12	28.06	HELS
N126	64.12	28.06	NORW
[old(HM8)]	64.1	28.1	old_HELS
HM25	65.8	28.1	HELS

Number of events found in the Helsinki bulletin: 29

Table 94: Events found in the Helsinki bulletin for area 29

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
2	5842	11/15/90	18:01:43.5	1.60	HA25		EXP	-
4	10023	11/29/90	11:09:33.5	1.55	old(HM8)		EXP	-
21	26092	6/13/91	09:09:29.2	1.28	64.28	27.93	-	-
22	27958	6/18/91	14:24:16.7	1.07	HM8		EXP	-
25	301795	11/19/91	14:03:50.8	1.46	HM8		EXP	-
28	313081	1/25/92	03:14:48.3	1.77	65.74	27.09	P.E.	-
29	319373	2/19/92	15:43:41.2	1.29	65.21	25.65	-	-
30	319295	2/18/92	12:00:41.5	1.89	64.22	27.47	-	-
34	327304	5/8/92	08:04:17.0	1.33	65.13	25.69	-	-
36	328556	5/21/92	11:33:03.2	1.17	65.18	25.87	-	-
38	328680	5/22/92	08:26:07.1	2.06	65.84	28.87	EART	-
26	302298	12/4/91	13:17:35.6	1.48	HM8		EXP	A
5	14119	3/12/91	12:14:13.4	1.52	old(HM8)		EXP	B
7	16776	4/2/91	11:29:50.1	1.42	64.24	27.96	-	B
8	18599	4/16/91	10:52:50.0	1.64	old(HM8)		EXP	B
11	22196	5/6/91	14:55:01.3	1.67	64.26	27.96	-	B
32	324831	4/15/92	15:10:41.3	1.12	HM8		EXP	C
35	328210	5/18/92	13:17:53.8	1.37	HM8		EXP	C
6	14427	3/20/91	14:10:58.7	1.03	old(HM8)		EXP	C
19	23465	5/22/91	11:26:09.1	1.61	65.06	25.73	-	D
31	324904	4/1/92	13:03:28.4	1.43	65.10	25.36	-	D
39	330139	6/10/92	12:50:26.7	1.40	65.09	25.70	-	D
1	5806	11/15/90	14:11:25.0	1.40	65.19	25.81	-	E
10	21860	5/3/91	07:35:25.4	1.27	65.15	25.7	-	E
23	319373	2/19/92	15:43:41.2	1.29	65.21	25.65	-	E
9	19829	4/25/91	11:31:16.0	1.69	64.89	26.37	-	F
12	21781	5/7/91	08:36:25.8	1.36	64.87	26.47	-	F

Table 94: Events found in the Helsinki bulletin for area 29

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
14	22604	5/10/91	05:04:02.1	1.49	65.01	25.44	-	F
18	23030	5/17/91	06:18:38.0	1.38	64.85	25.99	-	F

Events with the most reliable classification:

Table 95: Sorted events for area 29

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
26	302298	12/4/91	13:17:35.6	64.2212	27.9764	1.48	A
27	303325	1/3/92	10:34:51.5	64.2715	28.1714	1.59	A
5	14119	3/12/91	12:14:13.4	64.2250	28.5060	1.52	B
7	16776	4/2/91	11:29:50.1	64.1935	28.0010	1.42	B
8	18599	4/16/91	10:52:50.0	64.2717	27.8544	1.64	B
11	22196	5/6/91	14:55:01.3	64.3083	28.4076	1.67	B
6	14427	3/20/91	14:10:58.7	64.0889	27.9812	1.03	C
32	324831	4/15/92	15:10:41.3	64.0018	27.7858	1.12	C
33	326412	4/29/92	13:04:20.5	65.5002	28.5165	0.85	C
35	328210	5/18/92	13:17:53.8	64.0260	28.2639	1.37	C
44	345364	12/11/92	13:32:24.8	64.9340	29.6531	1.83	C
16	22125	5/13/91	09:56:59.8	65.1374	26.2735	1.35	D
17	22868	5/16/91	11:41:26.2	65.8739	26.2947	1.13	D
19	23465	5/22/91	11:26:09.1	65.1247	26.0420	1.61	D
20	24793	5/31/91	09:34:41.0	65.1872	26.0845	1.34	D
24	36185	8/23/91	20:01:59.9	65.1477	26.4854	0.99	D
31	324904	4/1/92	13:03:28.4	65.1798	26.1041	1.43	D
39	330139	6/10/92	12:50:26.7	65.2162	26.2577	1.40	D
1	5806	11/15/90	14:11:25.0	65.1510	26.1431	1.40	E
10	21860	5/3/91	07:35:25.4	65.1929	26.0641	1.27	E
23	35796	8/20/91	17:59:15.3	65.1836	26.1148	1.31	E
9	19829	4/25/91	11:31:16.0	64.9855	27.3959	1.69	F
12	21781	5/7/91	08:36:25.8	65.0623	26.3808	1.36	F

Table 95: Sorted events for area 29

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
14	22604	5/10/91	05:04:02.1	64.9271	26.9928	1.49	F
18	23030	5/17/91	06:18:38.0	65.0434	26.4565	1.38	F
42	343478	11/16/92	13:22:37.9	64.6468	28.1205	-	F

Remarks:

- Several events from groups A, B and C were identified as being from the same mine HM8 according to the Helsinki bulletin.
- The locations of the events from groups D, E and F form a cluster on the West part of the map shown in Figure 30. No mine has been reported close to these events.

Mine and event locations:

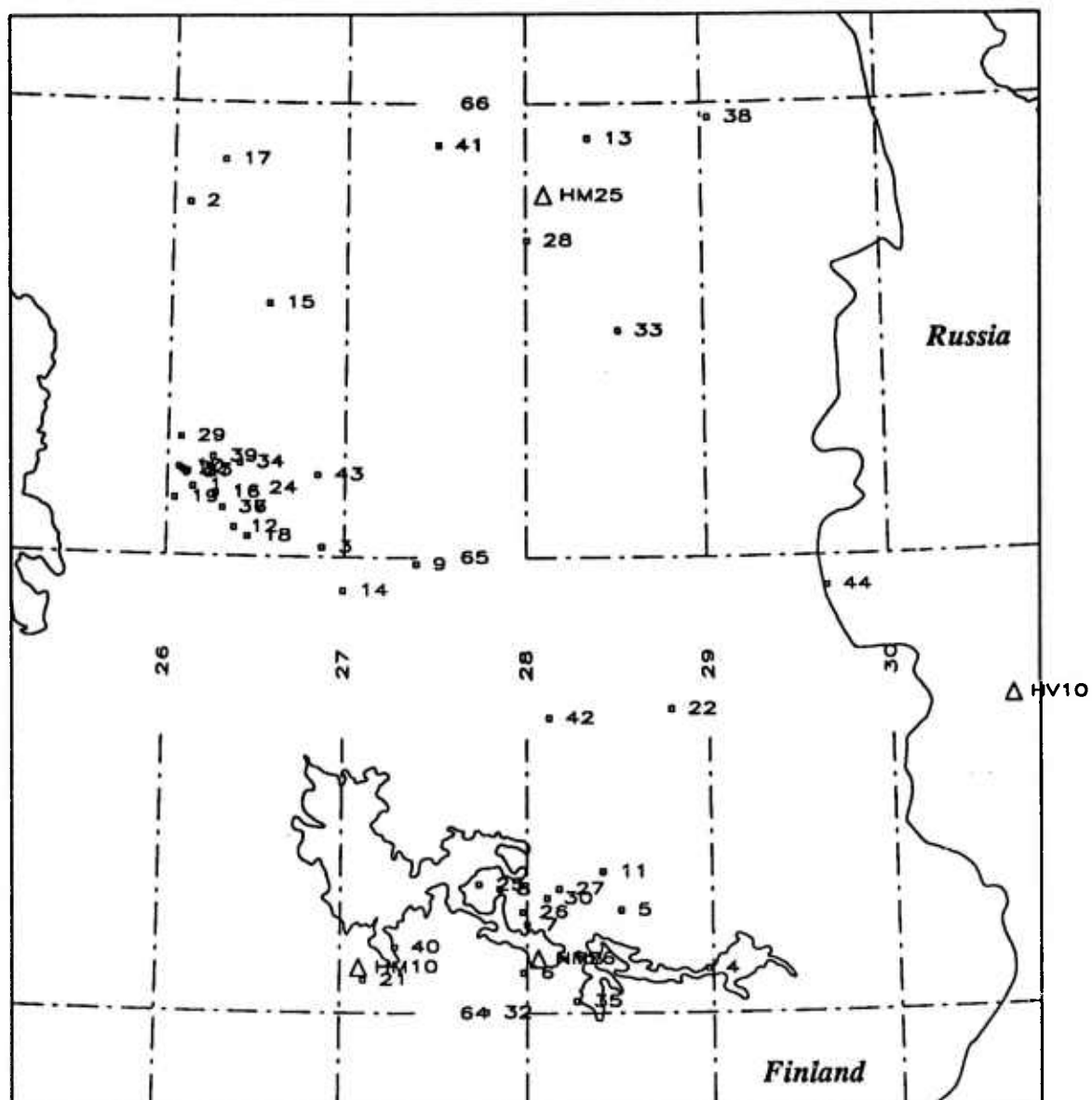


Figure 30: Mine and IMS event locations for area 29.

AREA 30

Latitude: 64 - 66°N

Longitude: 30 - 36°E

Local magnitude range: > 2.0

Number of events in IMS2: 155

Number of events within the magnitude range: 89

Number of processed events: 68

Frequency range used to process the data: 3 - 16 Hz

Processed signal length: 11s. before P, 101s. after P

Number of reference events: 8

Table 96: Reference events for area 30

Event #	IMS orid	IMS arid	IMS wfid	Threshold	Group
53	327905	1276393	2048914	0.70	A
46	315353	1164717	1671642	0.79	B
35	301860	1006904	1424422	0.81	C
49	320979	1215815	1820571	0.79	D
30	300151	1000359	1287842	0.80	E
62	338267	1429351	2655546	0.81	F
52	325447	1235151	1974906	0.80	G
31	301009	1003623	1431418	0.79	H

Reported mine locations:

Table 97: Mine locations for area 30

Label	Latitude °N	Longitude °E	Origin
HC17	64.7	30.7	old_HELS
HV10	64.68	30.66	HELS

Number of events found in the Helsinki bulletin: 58

Table 98: Events found in the Helsinki bulletin for area 30

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
21	29369	7/10/91	12:32:18.9	2.40	HV10		EXP	-
7	7024	12/28/90	10:31:13.6	2.23	HC17		EXP	A
13	16671	3/29/91	16:12:40.7	2.26	HC17		EXP	A
14	16669	3/29/91	16:13:01.5	2.30	HC17		EXP	A
15	19725	4/24/91	11:59:39.2	2.35	64.74	30.77	P. QB	A
18	24848	5/31/91	10:40:37.2	2.53	64.64	30.84	-	A
20	28157	6/26/91	11:00:13.3	2.67	HV10		EXP	A
27	35834	8/21/91	13:15:57.5	2.04	HV10		EXP	A
29	36719	8/28/91	12:00:31.7	2.25	HV10		EXP	A
37	302406	11/29/91	11:00:27.0	2.17	HV10		EXP	A
42	302974	12/18/91	11:01:28.4	2.25	HV10		EXP	A
44	313144	1/10/92	11:02:14.3	2.50	HV10		EXP	A
45	313692	1/17/92	11:00:31.4	2.30	HV10		EXP	A
50	325713	4/3/92	09:04:52.4	2.62	HV10		EXP	A
53	327905	5/15/92	09:22:22.2	2.20	HV10		EXP	A
54	329812	6/5/92	09:01:28.0	2.06	HV10		EXP	A
57	332865	7/10/92	10:00:09.4	2.32	HV10		EXP	A
58	333605	7/17/92	10:01:57.7	2.31	HV10		EXP	A
9	7858	1/16/91	10:10:54.5	2.15	HC17		EXP	B
12	15113	3/20/91	12:07:55.8	2.38	HC17		EXP	B
26	31673	7/24/91	10:00:05.9	2.49	HV10		EXP	B
28	35835	8/21/91	13:16:16.9	2.21	HV10		EXP	B
38	302781	12/6/91	10:14:50.2	2.08	HV10		EXP	B
46	315353	1/31/92	10:00:44.5	2.62	HV10		EXP	B
60	334046	7/22/92	09:00:01.2	2.08	HV10		EXP	B
11	14366	3/13/91	10:01:28.4	2.08	HC17		EXP	C
19	25678	6/5/91	12:21:08.1	2.03	HV10		EXP	C
35	301860	11/20/91	11:05:58.8	2.11	HV10		EXP	C

Table 98: Events found in the Helsinki bulletin for area 30

Event #	IMS orid	IMS origin time		IMS ml	HEL location		HEL lab	Group
25	30078	7/12/91	11:40:17.3	2.62	HV10		EXP	D
40	302703	12/11/91	11:16:29.8	2.13	HV10		EXP	D
47	319402	2/21/92	11:01:53.5	2.72	HV10		EXP	D
49	320979	3/18/92	10:00:36.1	2.67	HV10		EXP	D
51	324430	4/10/92	11:00:47.8	2.38	HV10		EXP	D
55	331053	6/19/92	09:12:53.5	2.01	HV10		EXP	D
56	332632	7/8/92	09:00:08.8	2.22	HV10		EXP	D
2	9494	11/28/90	12:01:18.4	2.77	HC17		EXP	E
3	42209	12/5/90	11:47:08.3	2.26	HC17		EXP	E
24	30075	7/12/91	11:00:12.2	2.62	HV10		EXP	E
30	300151	10/2/91	14:31:25.3	2.41	HV10		EXP	E
33	301385	11/6/91	11:22:24.9	2.36	HV10		EXP	E
5	314418	12/21/90	12:00:34.5	2.54	HC17		EXP	E
6	7261	12/25/90	11:00:38.3	2.05	HC17		EXP	E
61	336551	8/21/92	09:09:29.4	2.07	64.61	30.71	-	E
10	11188	1/18/91	10:00:07.5	2.23	HC17		EXP	F
17	23101	5/17/91	10:30:23.2	2.35	64.73	30.93	-	F
48	319737	3/4/92	11:20:19.2	2.22	HV10		EXP	F
62	338267	9/9/92	11:00:32.4	2.04	64.83	30.76	-	F
1	5892	11/16/90	12:41:20.4	2.65	HC17		EXP	G
4	300010	12/7/90	10:02:26.1	2.41	HC17		EXP	G
8	6314	1/8/91	10:41:03.1	2.58	HC17		EXP	G
34	301671	11/15/91	11:04:11.6	2.31	HV10		EXP	G
36	301977	11/22/91	11:00:28.6	2.21	HV10		EXP	G
39	302782	12/6/91	10:36:24.2	2.27	HV10		EXP	G
41	302847	12/13/91	11:22:05.9	2.45	HV10		EXP	G
43	303526	12/25/91	11:04:46.1	2.68	HV10		EXP	G
52	325447	4/22/92	09:00:25.3	2.44	HV10		EXP	G
31	301009	11/1/91	11:00:14.3	2.06	HV10		EXP	H
32	301013	11/1/91	11:00:20.7	2.11	HV10		EXP	H

Events with the most reliable classification:

Table 99: Sorted events for area 30

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
7	7024	12/28/90	10:31:13.6	64.7131	30.9240	2.23	A
13	16671	3/29/91	16:12:40.7	64.5862	31.3631	2.26	A
14	16669	3/29/91	16:13:01.5	64.8205	30.6343	2.30	A
15	19725	4/24/91	11:59:39.2	64.7111	30.4908	2.35	A
18	24848	5/31/91	10:40:37.2	64.7029	30.8697	2.53	A
20	28157	6/26/91	11:00:13.3	64.7586	30.4693	2.67	A
21	29369	7/10/91	12:32:18.9	64.7475	30.6243	2.40	A
22	29368	7/10/91	12:32:21.8	64.6918	31.1169	2.39	A
27	35834	8/21/91	13:15:57.5	64.9965	30.4838	2.04	A
29	36719	8/28/91	12:00:31.7	64.6505	31.0328	2.25	A
37	302406	11/29/91	11:00:27.0	64.7167	30.7461	2.17	A
42	302974	12/18/91	11:01:28.4	64.7268	30.6293	2.25	A
44	313144	1/10/92	11:02:14.3	64.7120	30.4328	2.50	A
45	313692	1/17/92	11:00:31.4	64.7104	30.7984	2.30	A
50	325713	4/3/92	09:04:52.4	64.6812	30.6402	2.62	A
53	327905	5/15/92	09:22:22.2	64.6953	30.6164	2.20	A
54	329812	6/5/92	09:01:28.0	64.8280	31.1102	2.06	A
57	332865	7/10/92	10:00:09.4	64.6169	30.8007	2.32	A
58	333605	7/17/92	10:01:57.7	64.8242	30.8389	2.31	A
65	343216	11/11/92	10:21:09.3	64.6721	31.2514	2.05	A
66	343678	11/18/92	10:20:07.6	64.6116	31.0726	2.69	A
67	345017	12/5/92	12:07:15.0	65.7648	33.8363	2.19	A
9	7858	1/16/91	10:10:54.5	64.6787	30.8695	2.15	B
12	15113	3/20/91	12:07:55.8	64.7100	30.7454	2.38	B
16	20326	4/30/91	11:59:38.2	64.7447	31.4725	2.36	B
26	31673	7/24/91	10:00:05.9	64.6904	30.9374	2.49	B
28	35835	8/21/91	13:16:16.9	64.9362	30.5581	2.21	B
38	302781	12/6/91	10:14:50.2	64.7089	30.6132	2.08	B

Table 99: Sorted events for area 30

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
46	315353	1/31/92	10:00:44.5	64.7431	30.8949	2.62	B
60	334046	7/22/92	09:00:01.2	64.6203	31.0863	2.08	B
11	14366	3/13/91	10:01:28.4	64.7254	30.5257	2.08	C
19	25678	6/5/91	12:21:08.1	64.7494	30.9318	2.03	C
35	301860	11/20/91	11:05:58.8	64.6957	30.7064	2.11	C
25	30078	7/12/91	11:40:17.3	64.7460	30.5994	2.62	D
40	302703	12/11/91	11:16:29.8	64.6979	30.8758	2.13	D
47	319402	2/21/92	11:01:53.5	64.6721	30.8014	2.72	D
49	320979	3/18/92	10:00:36.1	64.6432	31.3529	2.67	D
51	324430	4/10/92	11:00:47.8	64.6151	30.6847	2.38	D
55	331053	6/19/92	09:12:53.5	65.0195	31.3989	2.01	D
56	332632	7/8/92	09:00:08.8	64.6028	31.0929	2.22	D
2	9494	11/28/90	12:01:18.4	64.7161	30.3620	2.77	E
3	42209	12/5/90	11:47:08.3	64.8508	30.5819	2.26	E
5	314418	12/21/90	12:00:34.5	64.6424	31.0487	2.54	E
6	7261	12/25/90	11:00:38.3	64.7310	30.4597	2.05	E
24	30075	7/12/91	11:00:12.2	64.6470	30.7655	2.62	E
30	300151	10/2/91	14:31:25.3	64.7046	30.5705	2.41	E
33	301385	11/6/91	11:22:24.9	64.5590	31.3018	2.36	E
61	336551	8/21/92	09:09:29.4	64.6493	31.2611	2.07	E
10	11188	1/18/91	10:00:07.5	64.6339	31.3025	2.23	F
17	23101	5/17/91	10:30:23.2	64.6549	31.1682	2.35	F
48	319737	3/4/92	11:20:19.2	64.6584	31.1588	2.22	F
62	338267	9/9/92	11:00:32.4	64.6602	30.9094	2.04	F
1	5892	11/16/90	12:41:20.4	64.6455	30.8761	2.65	G
4	300010	12/7/90	10:02:26.1	64.8053	31.4884	2.41	G
8	6314	1/8/91	10:41:03.1	64.7149	30.9548	2.58	G
34	301671	11/15/91	11:04:11.6	64.4891	31.6611	2.31	G
36	301977	11/22/91	11:00:28.6	64.7114	30.4926	2.21	G
39	302782	12/6/91	10:36:24.2	64.7337	30.4234	2.27	G

Table 99: Sorted events for area 30

Event #	IMS orid	IMS origin time		IMS lat	IMS lon	IMS ml	Group
41	302847	12/13/91	11:22:05.9	64.6793	30.6006	2.45	G
43	303526	12/25/91	11:04:46.1	64.6965	30.3746	2.68	G
52	325447	4/22/92	09:00:25.3	64.6782	30.6175	2.44	G
64	342150	10/23/92	09:59:21.8	64.9698	30.6289	2.04	G
68	346736	12/30/92	10:00:26.9	65.0663	31.0947	2.01	G
31	301009	11/1/91	11:00:14.3	64.7579	30.6924	2.06	H
32	301013	11/1/91	11:00:20.7	64.7151	31.1655	2.11	H
63	341475	10/16/92	11:59:24.3	64.7025	31.4826	2.18	H

Remarks:

- According to the Helsinki bulletin, most of these events come from mine HV 10.
- The IMS locations of these events are close to this mine, except for event 67 located in the North-East of the map (Figure 31). The IMS expert solution for the location of this event was labeled by the analyst as being poor, but was still validated.

Mine and event locations:

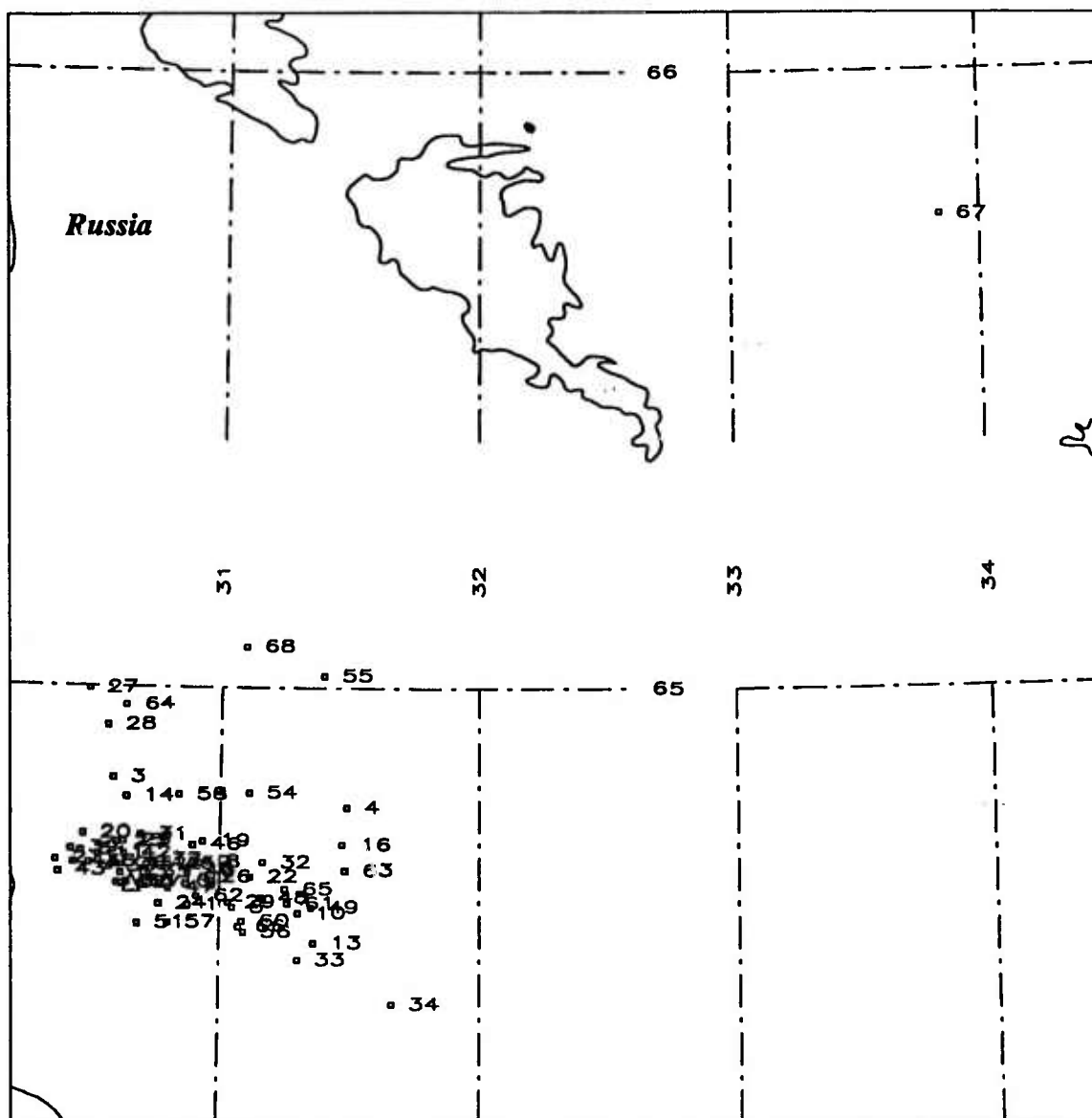


Figure 31: Mine and IMS event locations for area 30.

APPENDIX 2

The following table gives the list of the processing parameters used to perform the waveform comparison for each area. Lat1, Lat2, Lon1, and Lon2 give the limits of each area. Lfc and Hfc give the low frequency and the high frequency corner in Hz, respectively, used in the filtering. Sbf and Saf give, in seconds, the time before the first arrival and the time after the first arrival, respectively, defining the signal length.

Table 100: Processing parameters for ARCESS data

Area	Lat1	Lat2	Lon1	Lon2	Lfc	Hfc	Sbf	Saf
1	70	72	18	24	2	16	4	38
2	70	72	24	28	3	16	4	34
3	70	72	28	32	1	16	4	34
4	68	70	12	18	5	16	9	84
5	68	70	18	22	2	16	6	56
6	68	70	22	26	2	16	4	39
7	68	70	26	30	1	16	5	45
8	68	69	30	32	3	16	8	73
9	68	68.5	32	34	2	16	8	68
10	68.5	69	32	34	3	16	7	61
11	69	70	30	31	1	16	6	51
12	69	70	31	32	2	16	5	47
13	69	70	32	34	2	16	7	59
14	68	70	34	38	3	16	9	79
15	66	68	34	38	2	16	9	79
16	67	68	32	34	1	16	10	86
17	67	68	32	33	2.5	16	10	86
18	66	67	30	34	3	16	10	96
19	66	68	26	32	2	16	6	56
20	66	68	26	30	3	16	5	45
21	66	68	22	26	3	16	8	68
22	66	67	18	22	5	16	8	68
23 ^a	67	67.5	18	22	1	16	7	62
24	67.5	68	18	22	2	16		59

Table 100: Processing parameters for ARCESS data

Area	Lat1	Lat2	Lon1	Lon2	Lfc	Hfc	Sbf	Saf
25	66	68	12	18	3	16	11	101
26	64	66	10	18	3	16	11	101
27	64	66	18	24	3	16	11	101
28	64	66	24	26	3	16	11	101
29	64	66	26	30	5	16	10	90
30	64	66	30	36	2	16	12	107

a. A band reject filter between 5 and 6 Hz would more appropriate to filter the events from this area.

APPENDIX 3

The mine locations provided in this appendix cover more than the studied area. Distance 1 defines the distance to the ARCESS array in degrees and Distance 2, in kilometers. Mines are ordered by increasing longitude.

Table 101: SPOT mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
SB8	59.230	24.235	10.36	1238.710	2.49
SB1	59.242	24.329	10.35	1237.03	2.30
SB11	59.243	27.833	10.38	1241.14	355.45
SB9	59.269	27.732	10.35	1237.55	355.64
SB10	59.306	27.626	10.31	1232.64	355.83
SB7	59.325	27.272	10.28	1228.91	356.52
SB6	59.327	27.070	10.27	1227.97	356.91
SB12	59.364	28.365	10.29	1229.58	354.36
SB14	59.369	28.527	10.29	1229.98	354.04
SB13	59.370	28.428	10.28	1229.24	354.24
SB2	59.407	24.591	10.18	1216.68	1.82
SB5	59.446	26.486	10.14	1212.13	358.04
SB16	59.482	29.930	10.27	1227.52	351.25
SB15	60.019	29.742	9.72	1162.13	351.15
SC3b	60.581	29.064	9.11	1089.55	352.08
SC3a	60.599	29.073	9.10	1087.48	352.04
SC2	60.699	29.178	9.01	1076.48	351.73
SC1a	60.747	28.836	8.93	1068.01	352.44
SC1c	60.749	28.854	8.93	1067.91	352.40
SC1b	60.753	28.846	8.93	1067.37	352.41
SC0	60.816	28.711	8.86	1058.85	352.66
SC4c	60.843	28.989	8.85	1057.81	352.02
SC4b	60.849	28.979	8.84	1057.02	352.03
SC4a	60.851	28.991	8.84	1056.88	352.00
SC19	60.852	30.096	8.93	1067.13	349.55

Table 101: SPOT mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
SC6	60.951	29.175	8.75	1046.55	351.50
SC7	60.961	29.312	8.75	1046.56	351.18
SC8	60.969	28.880	8.72	1041.96	352.15
SC9	60.974	29.054	8.72	1042.79	351.75
SC10	60.985	29.275	8.73	1043.39	351.24
SC5b	60.999	29.026	8.70	1039.59	351.79
SC5c	61.005	29.043	8.69	1039.02	351.74
SC5a	61.008	29.016	8.69	1038.43	351.80
SC11c	61.120	29.902	8.65	1033.47	349.67
SC11b	61.132	29.823	8.63	1031.23	349.83
SC11a	61.133	29.845	8.63	1031.34	349.78
SC12d	61.199	29.727	8.55	1022.34	349.97
SC12c	61.201	29.731	8.55	1022.15	349.96
SC12b	61.204	29.727	8.55	1021.75	349.97
SC12a	61.208	29.727	8.54	1021.28	349.96
SC13	61.270	29.804	8.49	1014.74	349.71
SC14	61.604	31.283	8.31	993.565	345.82
SC17	61.664	31.654	8.30	991.958	344.87
SC15b	61.666	31.144	8.24	984.421	346.04
SC15a	61.672	31.139	8.23	983.653	346.04
SC16	61.691	31.274	8.23	983.321	345.70
SC18b	61.946	30.606	7.90	944.600	346.85
SC18a	61.952	30.575	7.89	943.502	346.92
SD44	67.607	33.486	3.51	419.675	307.12
SD43	67.645	32.912	3.31	396.102	308.34
SD42	67.759	32.824	3.22	384.554	307.03
SD41	67.803	32.781	3.18	379.824	306.53
SD49	67.889	34.566	3.69	441.618	300.73

Table 101: SPOT mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
SD40	67.893	33.029	3.20	382.702	304.46
SD50	67.895	34.615	3.71	443.158	300.55
SD47	67.916	34.385	3.62	432.924	300.75
SD48	67.926	34.486	3.65	436.243	300.40
SD46	68.006	34.697	3.68	439.762	298.89
SD45	68.019	34.349	3.56	425.319	299.39
SD39	68.040	33.229	3.18	380.626	301.68
SD38	68.082	33.219	3.16	377.616	301.06
SD37	68.112	32.986	3.07	366.807	301.20
SD35	68.120	33.400	3.20	382.288	300.01
SD36	68.133	33.162	3.11	372.289	300.40
SD34	68.251	33.267	3.09	369.437	298.24
SD33	68.268	33.403	3.13	373.830	297.65
SD32	68.700	33.125	2.86	341.371	290.61
SD31	68.791	33.146	2.83	338.543	288.84
SD30	68.792	33.133	2.83	337.969	288.84
SD29	68.872	33.025	2.76	330.521	287.43
SD28	68.930	33.096	2.77	331.448	286.18
SD18	68.932	34.938	3.41	408.182	284.60
SD27	68.943	32.965	2.72	325.576	286.08
SD26	68.997	32.871	2.68	319.927	285.07
SD25	68.999	32.910	2.69	321.488	284.99
SD23	69.012	33.641	2.94	351.583	284.07
SD24	69.013	32.939	2.70	322.265	284.67
SD22	69.034	33.506	2.89	345.307	283.75
SD21	69.060	33.484	2.87	343.658	283.26
SD17	69.064	35.008	3.41	407.414	282.40
SD16	69.070	35.008	3.41	407.260	282.30

Table 101: SPOT mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
SD20	69.093	33.482	2.87	342.686	282.62
SD19	69.111	33.594	2.90	346.913	282.20
SD15	69.223	33.168	2.73	326.429	280.16
SD14	69.256	33.106	2.70	323.149	279.49
SD12	69.276	32.811	2.60	310.367	279.16
SD13	69.286	32.903	2.63	314.044	278.91
SD11	69.299	32.721	2.56	306.157	278.68
SD4	69.329	30.019	1.61	192.217	279.50
SD2	69.367	30.093	1.63	194.620	278.09
SD3	69.368	30.134	1.64	196.324	278.02
SD7	69.398	30.614	1.81	216.018	276.75
SD8	69.401	30.847	1.89	225.767	276.58
SD9	69.409	30.953	1.93	230.115	276.31
SD10	69.410	32.135	2.34	279.794	276.17
SD6	69.432	30.527	1.77	211.918	275.69
SD5	69.435	30.531	1.77	212.051	275.59
SD1	69.597	30.049	1.60	190.838	269.89

Two tables are provided for the Helsinki mine locations. The locations shown in Table 102 started to be used at the beginning of June 1991. A mapping between the new Helsinki locations and the old Helsinki locations is proposed in this table. Certain mines can have up to four different locations reported in the Helsinki bulletin; only the most frequent are listed. Locations given with one decimal were obtained by averaging seismic locations; locations with two decimals were obtained from the SPOT imagery.

Table 102: Helsinki mine locations

Label	Old label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HE1	HB1	59.24	24.33	10.35	1237.270	2.30
HE5A	HB9	59.24	27.83	10.39	1241.480	355.46
HE5	HB9	59.27	27.73	10.35	1237.420	355.64

Table 102: Helsinki mine locations

Label	Old label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HE6A	HB10	59.3	27.5	10.31	1232.810	356.08
HE7	HB11	59.3	28.1	10.34	1235.700	354.91
HE6	HB10	59.31	27.63	10.31	1232.180	355.82
HE4	HB6	59.33	27.27	10.28	1228.310	356.52
HE4A	HB6	59.33	27.07	10.27	1227.610	356.91
HE12A	HB12	59.36	28.37	10.29	1230.080	354.35
HE12	HB12	59.37	28.43	10.28	1229.260	354.23
HE8	HB13	59.37	28.53	10.29	1229.880	354.04
HE2	HB2	59.41	24.59	10.18	1216.320	1.82
HE9	HB5	59.45	26.49	10.14	1211.660	358.03
HE3	HB3	59.5	25.0	10.08	1204.910	1.02
HE11	HB16	59.6	30.0	10.16	1214.190	351.01
HE10	HB15	60.0	29.9	9.75	1165.860	350.85
HE10A	HB15	60.02	29.74	9.72	1161.990	351.15
HM1	HA1	60.17	23.84	9.43	1127.390	3.58
HM3	HA2	60.30	22.29	9.37	1120.340	6.96
HV11	HC3	60.6	29.2	9.11	1088.420	351.77
HV12	HC1	60.7	28.7	8.97	1072.570	352.78
HV5	HC2	60.7	29.0	8.99	1074.890	352.12
HV13	HC7	60.8	29.5	8.93	1067.350	350.92
HV1B	HC4	60.8	29.3	8.91	1065.550	351.36
HV1A	HC6	60.9	29.4	8.82	1054.590	351.04
HV1C	HC5	60.9	29.3	8.81	1053.690	351.26
HV2	HC11	61.1	30.3	8.70	1040.140	348.80
HV8	HC11	61.1	29.9	8.66	1035.800	349.70
HM2	HA3	61.33	23.03	8.30	992.660	6.04
HV4	HC14	61.4	31.6	8.55	1021.780	345.45
HV6	HC15	61.4	34.3	8.94	1068.340	339.75

Table 102: Helsinki mine locations

Label	Old label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HV3	HC12	61.5	30.4	8.32	994.286	348.03
HM5	HA4	61.6	21.7	8.12	970.875	9.51
HM26	HA5	61.64	24.26	7.95	949.899	3.17
HM4	HA6	61.9	21.5	7.84	937.384	10.37
HV7	HC13	61.9	30.6	7.95	949.899	346.94
HM27	-	61.94	29.03	7.76	928.021	350.79
HM6	HA7	62.07	27.41	7.54	901.123	354.89
HV9	HC16	62.2	34.3	8.19	978.847	337.82
HM15	HA8	62.5	30.1	7.31	873.457	347.20
HM21	HA9	62.6	23.6	7.01	837.805	5.50
HM20	HA10	62.7	23.2	6.93	828.226	6.74
HM14	HA11	62.8	22.9	6.85	818.395	7.71
HM12	HA12	62.83	29.25	6.90	825.018	348.98
HM18	HA14	63.0	26.8	6.59	787.184	356.03
HM19	HA13	63.02	29.23	6.71	802.434	348.73
HM7	HA15	63.12	27.74	6.51	777.713	353.05
HM17	HA16	63.16	27.99	6.48	774.690	352.24
HM23	HA18	63.3	29.3	6.44	770.283	348.03
HM16	HA17	63.4	27.3	6.20	741.663	354.15
HM13	HA19	63.66	26.05	5.91	705.992	358.14
HM24	HA20	63.85	25.05	5.71	683.054	1.61
HM10	HA22	64.1	27.1	5.50	656.995	354.14
HM9	HA21	64.1	24.7	5.47	653.804	2.97
HM8	HA23	64.12	28.06	5.53	661.291	350.64
HM11	HA24	64.41	25.15	5.15	615.717	1.39
HV10	HC17	64.68	30.66	5.27	630.425	339.89
HM22	HA25	65.78	24.70	3.79	452.502	4.30
HM25	HA26	65.8	28.10	3.88	463.898	346.40

Table 102: Helsinki mine locations

Label	Old label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HR3	HE1	67.12	20.90	2.97	354.734	33.06
HR1	HE1	67.18	20.67	2.97	354.764	34.94
HK8	HD1	67.56	30.44	2.69	321.321	319.83
HK5	HD10	67.6	34.2	3.74	446.567	305.31
HK1A	HD8/HD9	67.63	33.84	3.61	431.064	305.85
HK2	HD8/HD9	67.64	34.02	3.66	437.065	305.26
HK2A	HD8/HD9	67.64	33.88	3.61	431.848	305.62
HR2	HE2	67.65	21.00	2.51	300.478	39.05
HK1	HD8	67.67	33.74	3.55	424.547	305.59
HK7	HD3	67.7	31.4	2.84	339.396	313.18
HM28	-	67.79	24.43	1.80	214.830	12.16
HR4	HE2	67.8	20.2	2.61	311.740	45.63
HK4	HD6	68.16	33.18	3.11	371.356	299.93
HK11	HD5	68.87	33.03	2.77	330.799	287.46
HK10	HD12	69.2	34.7	3.27	391.275	280.18
HK12	HD7	69.23	33.17	2.73	326.366	280.01
HK9	HD11	69.3	34.4	3.15	376.717	278.44
HK3	HD2	69.4	30.8	1.87	223.806	276.63
HK6	HD4	69.6	32.3	2.39	285.180	271.61
HN1	HF1	69.6	29.9	1.54	184.594	269.63

Table 103: Old Helsinki mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HB9	59.2	27.6	10.417	1158.32	355.924
HB1	59.3	24.4	10.289	1144.09	2.178
HB10	59.3	27.6	10.317	1147.2	355.884
HB11	59.3	28.1	10.337	1149.43	354.910
HB6	59.3	27.2	10.303	1145.65	356.667

Table 103: Old Helsinki mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HB12	59.4	28.4	10.252	1139.98	354.273
HB13	59.4	28.5	10.257	1140.53	354.078
HB2	59.4	24.6	10.185	1132.53	1.802
HB3	59.5	25.0	10.080	1120.85	1.016
HB5	59.5	26.5	10.086	1121.52	358.003
HB16	59.6	30.0	10.157	1129.41	351.009
HB15	60.0	29.9	9.753	1084.49	350.847
HA1	60.2	23.1	9.429	1048.46	5.170
HA2	60.4	22.4	9.266	1030.34	6.797
HC3	60.6	29.2	9.105	1012.43	351.767
HC1	60.7	28.7	8.972	997.645	352.781
HC2	60.7	29.0	8.992	999.869	352.117
HC4	60.8	29.3	8.914	991.196	351.361
HC7	60.8	29.5	8.929	992.864	350.918
HC5	60.9	29.3	8.815	980.187	351.264
HC6	60.9	29.4	8.822	980.966	351.040
HC10 ^a	61.1	39.9	10.351	1150.98	330.883
HC11	61.1	30.2	8.692	966.51	349.020
HA3	61.4	22.8	8.246	916.917	6.647
HC14	61.4	31.6	8.548	950.498	345.450
HC15	61.4	34.3	8.937	993.753	339.749
HC12	61.5	30.4	8.318	924.923	348.028
HA4	61.6	21.7	8.122	903.129	9.511
HA5	61.6	24.2	7.988	888.229	3.306
HA6	61.9	21.5	7.842	871.994	10.375
HC13	61.9	30.6	7.946	883.559	346.944
HA7	62.1	27.4	7.508	834.855	354.895
HC16	62.2	34.3	8.188	910.468	337.819

Table 103: Old Helsinki mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HA8	62.5	30.1	7.307	812.505	347.203
HA9	62.6	23.6	7.009	779.369	5.501
HA10	62.7	23.2	6.928	770.362	6.736
HA11	62.8	22.9	6.846	761.244	7.709
HA12	62.8	29.3	6.936	771.251	348.887
HA13	62.9	28.7	6.787	754.683	350.455
HA14	63.0	26.8	6.585	732.222	356.028
HA15	63.2	27.8	6.430	714.986	352.777
HA16	63.2	28.1	6.448	716.988	351.850
HA17	63.4	27.3	6.204	689.856	354.152
HA18	63.5	29.6	6.277	697.974	346.723
HA19	63.7	26.0	5.865	652.161	358.299
HA20	63.8	25.1	5.764	640.93	1.421
HA21	64.1	24.7	5.469	608.128	2.975
HA22	64.1	27.1	5.496	611.13	354.136
HA23	64.2	28.0	5.448	605.793	350.723
HA24	64.4	25.2	5.160	573.768	1.196
HC17	64.7	30.7	5.261	584.999	339.680
HA25	65.8	24.7	3.765	418.651	4.319
HA26	65.8	28.1	3.881	431.549	346.396
HE1	67.1	20.6	3.049	339.035	34.430
HD1	67.6	30.5	2.672	297.114	318.953
HD10	67.6	34.2	3.736	415.426	305.315
HD9	67.6	34.0	3.673	408.421	305.819
HD3	67.7	31.4	2.839	315.684	313.183
HD8	67.7	33.7	3.522	391.63	305.303
HE2	67.7	21.0	2.475	275.209	39.783
HD6	68.1	33.2	3.143	349.487	300.827

Table 103: Old Helsinki mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
HD5	68.8	33.0	2.779	309.012	288.881
HD12	69.2	34.7	3.273	363.943	280.184
HD7	69.2	33.3	2.781	309.234	280.580
HD11	69.3	34.4	3.151	350.377	278.445
HD2	69.2	30.8	1.872	208.158	276.626
HD4	69.2	32.3	2.386	265.312	271.612
HF1	69.6	29.9	1.544	171.686	269.630

a. This mine does not have a corresponding new location.

Table 104: Norwegian mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
N15	58.300	6.400	13.96	1669.200	28.49
N205	58.800	15.100	11.67	1394.550	18.31
N206	59.300	15.400	11.14	1331.810	18.63
N209	59.700	14.100	10.99	1313.850	21.40
N16	59.750	10.770	11.63	1390.170	26.35
N14	59.900	10.500	11.56	1381.420	27.04
N208	60.000	14.800	10.58	1265.070	20.84
N109	60.100	22.880	9.54	1140.350	5.58
N207	60.100	15.000	10.45	1249.600	20.70
N202	60.120	17.520	10.03	1199.380	16.29
N121	60.140	22.590	9.51	1137.360	6.21
N110	60.170	23.840	9.43	1127.390	3.58
N204	60.185	16.115	10.18	1217.390	18.94
N203	60.200	16.130	10.17	1215.390	18.94
N111	60.250	25.390	9.32	1114.700	0.25
N112	60.270	24.070	9.32	1114.610	3.12

Table 104: Norwegian mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
N113	60.300	22.290	9.37	1120.340	6.96
N201	60.620	15.100	9.95	1189.280	21.57
N210	60.700	15.900	9.73	1163.470	20.31
N13	60.740	11.020	10.69	1277.820	28.31
N114	61.030	28.180	8.61	1029.680	353.71
N115	61.050	22.640	8.60	1028.560	6.75
N103	61.180	28.040	8.46	1010.910	353.93
N101	61.330	23.030	8.30	992.660	6.04
N116	61.810	21.740	7.91	945.651	9.66
N6	61.930	5.450	11.18	1335.950	38.48
N117	61.940	29.030	7.76	928.021	350.79
N1	62.040	5.523	11.07	1323.060	38.76
N102	62.040	28.770	7.65	913.888	351.34
N118	62.070	27.410	7.54	901.123	354.89
N122	62.820	29.250	6.91	826.196	349.00
N123	63.020	29.230	6.71	802.434	348.73
N124	63.120	27.740	6.51	777.713	353.05
N119	63.150	24.020	6.44	770.017	4.66
N125	63.160	27.990	6.48	774.690	352.24
N104	63.660	26.050	5.91	705.992	358.14
N105	63.850	25.050	5.71	683.054	1.61
N218	63.867	20.217	6.07	725.049	17.87
N215	63.917	20.100	6.03	721.264	18.37
N219	63.917	20.300	6.01	717.987	17.76
N217	63.933	20.067	6.02	719.931	18.53
N220	64.050	20.717	5.82	696.179	16.82
N9	64.070	11.200	7.85	938.973	39.49
N216	64.100	19.583	5.94	709.582	20.54

Table 104: Norwegian mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
N126	64.120	28.060	5.53	661.291	350.64
N214	64.133	18.567	6.07	725.969	23.68
N106	64.410	25.150	5.15	615.717	1.39
N7	64.870	13.880	6.50	776.824	38.77
N107	65.780	24.700	3.79	452.502	4.30
N120	65.900	24.470	3.67	439.132	5.69
N8	65.930	13.880	5.71	682.252	45.46
N213	66.133	17.183	4.65	555.392	38.94
N3	66.421	14.679	5.13	613.573	47.60
N212	67.083	20.967	2.98	356.759	32.32
N5	67.148	16.070	4.24	506.675	51.27
N108	67.790	24.430	1.80	214.831	12.16
N211	67.833	20.205	2.58	308.817	46.13
N400	69.420	30.800	1.87	223.541	276.01
N4	69.652	30.025	1.59	189.976	267.88

Table 105: Mine locations from other sources

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
TIT	58.23	6.43	14.018	1558.74	28.330
BLA	59.31	6.95	12.940	1438.87	29.989
NYG	60.39	5.34	12.453	1384.72	34.213
Varanger	70.480	28.500	1.40	155.764	228.72

Table 106: JOG mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
JOG1	59.650	9.680	11.97	1430.810	27.55
JOG2	59.660	9.650	11.97	1430.590	27.61
JOG3	59.660	9.690	11.96	1429.460	27.56
JOG4	59.670	9.680	11.95	1428.680	27.59
JOG5	59.680	9.680	11.94	1427.620	27.61
JOG6	59.690	9.540	11.97	1430.510	27.81
JOG7	59.760	9.810	11.84	1415.470	27.63
JOG8	59.770	9.520	11.90	1422.590	28.02
JOG9	59.790	9.500	11.89	1421.050	28.09
JOG10	62.040	10.820	9.61	1148.870	32.28
JOG11	62.100	10.210	9.72	1161.430	33.35
JOG12	62.100	9.800	9.82	1174.200	33.92
JOG13	62.110	9.820	9.81	1172.580	33.93
JOG14	62.110	9.900	9.79	1170.070	33.82
JOG15	62.130	10.090	9.72	1162.150	33.62
JOG16	62.150	10.080	9.71	1160.460	33.70
JOG17	62.150	10.680	9.55	1141.990	32.84
JOG18	62.280	10.320	9.54	1140.030	33.78
JOG19	62.320	10.600	9.43	1127.360	33.51
JOG20	62.330	10.620	9.42	1125.750	33.52
JOG21	62.380	10.400	9.43	1127.580	34.01
JOG22	62.380	10.420	9.43	1126.950	33.98
JOG23	62.410	10.270	9.44	1128.660	34.29
JOG24	62.410	10.280	9.44	1128.350	34.28
JOG25	62.440	10.860	9.26	1107.360	33.53
JOG26	62.440	10.870	9.26	1107.05	33.52
JOG27	62.520	11.220	9.10	1088.34	33.26
JOG28	62.540	11.100	9.12	1090.00	33.51

Table 106: JOG mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
JOG29	62.540	11.250	9.08	1085.42	33.29
JOG30	62.550	11.810	8.93	1067.57	32.44
JOG31	62.570	11.820	8.91	1065.25	32.49
JOG32	62.630	11.550	8.93	1067.29	33.13
JOG33	62.670	11.280	8.96	1071.49	33.69
JOG34	62.690	11.280	8.95	1069.50	33.76
JOG35	62.710	11.280	8.93	1067.50	33.83
JOG36	62.770	11.280	8.88	1061.53	34.05
JOG37	62.790	11.250	8.87	1060.47	34.17
JOG38	62.810	11.260	8.85	1058.17	34.22
JOG39	62.820	10.050	9.16	1095.44	36.05
JOG40	62.840	11.550	8.75	1046.28	33.88
JOG41	62.870	11.630	8.71	1040.84	33.86
JOG42	62.920	11.680	8.65	1034.34	33.96
JOG43	62.940	11.500	8.68	1037.88	34.32
JOG52	67.070	20.970	3.00	358.027	32.16
JOG44	67.180	20.620	2.98	356.104	35.20
JOG45	67.180	20.670	2.97	354.764	34.94
JOG46	67.200	20.670	2.95	352.798	35.16
JOG47	67.200	20.710	2.94	351.728	34.95
JOG68	67.350	32.530	3.40	406.023	313.45
JOG70	67.450	32.660	3.37	402.314	311.74
JOG69	67.550	30.330	2.67	319.011	320.56
JOG53	67.630	21.030	2.52	301.490	38.59
JOG54	67.670	33.630	3.52	420.468	305.89
JOG48	67.830	20.190	2.59	309.557	46.15
JOG49	67.880	20.230	2.54	304.106	46.77
JOG56	67.880	34.550	3.69	441.550	300.89

Table 106: JOG mine locations

Label	Latitude	Longitude	Distance 1	Distance 2	Azimuth
JOG57	67.900	34.630	3.71	443.438	300.45
JOG55	67.930	34.480	3.65	435.766	300.36
JOG61	68.010	34.710	3.68	440.043	298.81
JOG60	68.020	34.370	3.56	426.083	299.34
JOG50	68.050	16.020	3.76	448.921	62.25
JOG58	68.150	33.250	3.13	374.669	299.91
JOG59	68.250	33.270	3.09	369.611	298.25
JOG51	68.470	16.050	3.57	426.531	68.19
JOG62	68.690	33.110	2.85	341.183	290.82
JOG63	68.820	35.370	3.60	429.796	286.09
JOG64	68.870	33.020	2.76	330.386	287.47
JOG65	68.930	33.080	2.77	330.784	286.20
JOG67	69.390	30.330	1.71	204.203	277.14
JOG66	69.420	30.280	1.69	201.685	276.16

APPENDIX 4

The following table gives the results of an attempt to associate reference events with a particular mine. For this purpose, the event identification reported in the Helsinki bulletin were used. An association was made between a group of events and the Helsinki identifications when, within a group, all Helsinki identifications were reasonably consistent. When both an old Helsinki location and a new Helsinki location were used to identify events within a group, only the new location was listed.

Events listed in *italic* are redundant. When a large number of events from the same source overlapped two adjacent areas, two reference events were defined, one for each area. These redundant events are not included in the list of reference events used in the database.

For each reference event, the table gives:

- the area number,
- the event orid used in the IMS database,
- the event number used in the processing,
- the event label corresponding to the grouping,
- the event location using the identification found in the Helsinki bulletin,
- the number of events found in the Helsinki bulletin with the same identification,
- comment about the groups: (1) defines event groups consisting of more than three events, (2) defines event groups including three or fewer events.

Table 107: Identification of the reference events

Area	Orid	Event #	Group	Source	# of events	Comment
1	339219	46	A	-	-	(1)
	30690	27	B	-	-	(1)
2	324318	37	A	-	-	(1)
	301540	20	B	-	-	(1)
	32522	7	C	-	-	(1)
3	345676	67	A	"	-	(1)
	14423	2	B	"	-	(1)
	29288	14	C	"	-	(1)
	335047	46	D	"	-	(1)
	335771	50	E		-	(1)
	331548 ^b	-	-	-	-	(1)

Table 107: Identification of the reference events

Area	Orid	Event #	Group	Source	# of events	Comment
5	330571	38	A	-	-	(2)
	15563	8	B	-	-	(1)
	19809	13	C	-	-	(2)
	28713	21	D	-	-	(2)
	332265	44	E	-	-	(1)
	341863	63	F	-	-	(1)
	327541	36	G	-	-	(2)
	22541	15	H	-	-	(2)
	333552	47	I	-	-	(1)
	35075	27	J	-	-	(2)
	16814	9	K	-	-	(2)
6	302474	15	A	EARTH.	1	(2)
	36875	8	B	-	-	(2)
	38132	13	C	-	2	(1)
7	301570	13	A	HN1	2	(1)
	344716	30	B	HN1	1	(1)
	8747	4	C	-	-	(2)
8	336069	43	A	HK1	1	(1)
	331799	35	B	HK4	1	(2)
	16175	7	C	-	-	(2)
	340138	46	D	-	-	(1)
	314771	25	E	-	-	(1)
9	20330	13	A	HK4 ^c	4	(1)
	3014	1	B	HK4	3	(2)
	30603	22	C	HK4 ^d	7	(1)
	302119	29	D	HK4	5	(1)
	325195	44	E	HK4	20	(1)
	333501	48	F	HD6 ^e	1	(2)

Table 107: Identification of the reference events

Area	Orid	Event #	Group	Source	# of events	Comment
10	300626	40	A	HK11	1	(2)
	16067	11	B	HD7 ^{c, f}	1	(1)
	312825	42	C	-	-	(2)
	30828	29	D	-	-	(1)
	331691	60	E	HK11 ^c	1	(1)
	14379	8	F	-	-	(1)
	7015	3	G	-	-	(1)
	36093	35	H	-	-	(2)
	34142	33	I	-	-	(1)
	41745	38	J	-	1	(1)
	345142	68	K	HD7 ^{c, f}	1	(1)
11	347014	125	A	HK3 ^c	3	(2)
	34154	40	B	HN1 ^c	4	(1)
	12932	18	C	HK3 ^c	7	(1)
	325993	83	D	g	7	(1)
	35098	41	E	HK3 ^c	2	(2)
	331516	97	F	HK3 ^h	77	(1)
12	26841	16	A	HK3 ^c	5	(1)
	344808	86	B	HK6 ^c	3	(1)
	19799	11	C	-	-	(2)
	36690	49	D	-	-	(1)

Table 107: Identification of the reference events

Area	Orid	Event #	Group	Source	# of events	Comment
13	28301	22	A	HK6 ^c	2	(1)
	22301	12	B	-	-	(2)
	302409	45	C	HD7 ^{c,f}	1	(1)
	323098	56	D	HK6 ^c	1	(1)
	40890	40	E	-	-	(1)
	27879	19	F	-	-	(1)
	30887	30	G	-	-	(1)
	344816	77	H	HK6 ^c	1	(1)
	33277	33	I	-	-	(2)
	34983	35	J	HK6 ^c	1	(1)
	321732	51	K	HK6 ^c	1	(2)
	302359	46	L	HD7 ^{c,f}	1	(1)
15	344686	37	A	c,i	12	(1)
	345204	38	B	c,i	8	(1)
16	11204	13	A	c,i	2	(2)
	8886	15	B	c,i	14	(1)
	6043	7	C	c,i	12	(1)
17	320658	52	A	c,i	7	(1)
	319424	48	B	HK2	1	(1)
	18753	11	C	c,i	2	(1)
	21835	15	D	c,i	3	(1)
	337114	68	E	HK1 ^c	2	(1)
	326612	56	F	c	3	(1)
	35869	30	G	HK4 ^c	6	(1)
	325214	54	H	-	-	(1)
18	14581	4	A	-	-	(1)
19	15006	9	A	HK8	5	(1)
	301141	32	B	HK8	7	(1)
	14388	8	C	HK7	2	(2)
	33671	26	D	HK8	34	(1)

Table 107: Identification of the reference events

Area	Orid	Event #	Group	Source	# of events	Comment
20	30083	39	A	HK8	9	(1)
	337343	76	B	HK8	8	(1)
	12936	16	C	HK8	2	(2)
	21201	33	D	-	-	(2)
	341310	84	E	HD1 ^j	1	(1)
	337790	78	F	-	5	(1)
	12657	18	G	HD1 ^j	1	(1)
21	312913	65	A	HM22	10	(1)
	340334	104	B	HM22	15	(1)
	336850	92	C	HM22 ^k	6	(1)
	35046	46	D	-	-	(2)
	18729	25	E	HR1	4	(1)
	15255	19	F	-	-	(2)
	334661	89	G	HR3 ^l	6	(1)
	303001	61	H	-	-	(1)
	337224	94	I	-	-	(1)
	337460	97	J	-	5	(1)
	312559	68	K	-	-	(2)
22	337588	43	A	-	-	(1)
	25494	10	B	HR1	4	(1)
	345699	62	C	-	-	(1)
	340339	47	D	-	-	(2)
	342809	53	E	-	-	(1)

Table 107: Identification of the reference events

Area	Orid	Event #	Group	Source	# of events	Comment
23	12948	12	A	HR1	3	(2)
	41528	36	B	HR1 ^m	3	(1)
	10111	6	C	HR1	12	(1)
	3297	3	D	HR1	3	(1)
	303421	46	E	HR1	1	(2)
	334722	75	F	HR1	1	(2)
	341042	82	G	-	-	(1)
	344601	95	H	-	-	(2)
	337216	79	I	-	-	(2)
	332148	73	J	-	-	(2)
24	302661	65	A	HR4	2	(1)
	35164	51	B	i	3	(1)
	328626	79	C	HR4	2	(1)
	38417	54	D	i	6	(1)
	327537	78	E	HR1	1	(2)
	19304	18	F	HE2 ⁿ	1	(2)
	10188	7	G	-	-	(2)
	332725	81	H	-	-	(1)
	333657	82	I	-	-	(2)
25	339193	99	A	-	2	(1)
	320060	61	B	P.E.	1	(1)
	326980	69	C	-	3	(1)
	303251	34	D	EARTH.	2	(1)
	313091	53	E	P.E. ^o	3	(1)
	331416	83	F	P.E. ^p	6	(1)
	312925	45	G	P.E. ^m	1	(1)

Table 107: Identification of the reference events

Area	Orid	Event #	Group	Source	# of events	Comment
28	16856	11	A	HM22	5	(1)
	341881	75	B	HM22	3	(1)
	22198	19	C	HM22	3	(1)
	344303	78	D	HM22	5	(1)
	301329	42	E	HM22	6	(1)
	21747	17	F	HM22	8	(1)
	321822	50	G	HM22	5	(1)
29	302298	26	A	HM8	1	(2)
	14119	5	B	HM8	2	(1)
	326412	33	C	HM8	3	(1)
	22125	16	D	-	3	(1)
	5806	1	E	-	2	(2)
	23030	18	F	-	2	(1)
30	327905	53	A	HV10	14	(1)
	315353	46	B	HV10	7	(1)
	301860	35	C	HV10	3	(2)
	320979	49	D	HV10	7	(1)
	300151	30	E	HV10	7	(1)
	338267	62	F	HV10	2	(1)
	325447	52	G	HV10	9	(1)
	301009	31	H	HV10	2	(2)

- a. Probably from Varanger mine. Not listed in the Helsinki bulletin.
- b. Event added to the original list.
- c. Several mines have been located on SPOT photos in this area or in the nearby areas.
- d. One event of this group was located at mine HK5.
- e. HD6: old HK4.
- f. HD7: old HK12
- g. Five events from this group are located at mine HN1 and two events at mine HK3
- h. One event of this group out of the seventy-three events reported in the Helsinki bulletin was located at HN1.
- i. Several events reported in the Helsinki bulletin, but important inconsistency between the group and the Helsinki identification.
- j. HD1: old HK8.
- k. One event of this group was located at mine HR3.

- l. One event of this group was identified as being "probably an earthquake" in the Helsinki bulletin
- m. One event of this group was located at mine HR3. The distance between mine HR1 and HR3 is 12 km.
- n. HE2: old HR2 and HR4
- o. One event from this group was identified in the Helsinki bulletin as being an "Earthquake".
- p. Two events from this group were identified in the Helsinki bulletin as being "Earthquakes".